Scenarios Network
FOR ALASKA & ARCTIC PLANNING

Climate Change Planning in Alaska's National Parks

Interior Arctic Parks
Webinar #2
March 14, 2012

Scenario Building:
Choosing drivers
(critical uncertainties)

Overall Project Summary

- Changing climatic conditions are rapidly impacting environmental, social, and economic conditions in and around National Park System areas in Alaska.

- Alaska park managers need to better understand possible climate change trends in order to better manage Arctic, subarctic, and coastal ecosystems and human uses.

- NPS and the University of Alaska's Scenarios Network for Alaska Planning (UAF-SNAP) are collaborating on a three-year project that will help Alaska NPS managers, cooperating personnel, and key stakeholders to develop plausible climate change scenarios for all NPS areas in Alaska.

NPS photos

Webinar #2 Goals

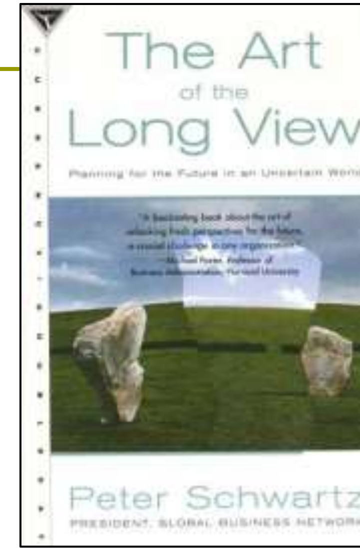
- Reminder of the role of climate drivers in the scenarios planning process
- Overview of scenario drivers (critical uncertainties) for Interior Arctic parks
- Discussion of a drivers table
- “Homework” assignments and preview of Webinar 3

Readings (pt. 1)

- *The Art of the Long View, emphasis on first 4 pages (p. 3-6); User's Guide (p. 227-239); and Appendix (p. 241-248)*.

  These can all be read for free in the page previews on Amazon ("Click to Look Inside") at

  http://www.amazon.com/Art-Long-View-Planning-Uncertain/dp/0385267320



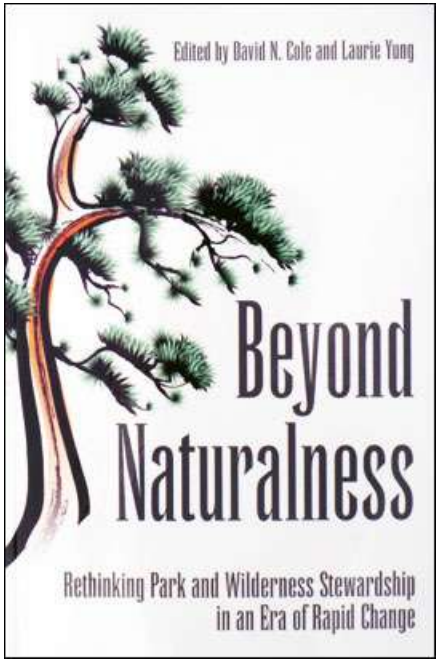
- SNAP one-page fact sheet *(Tools for Planners)* and link to website for optional browsing, plus detailed notes from the August and February meetings, online at

  http://snap.uaf.edu/webshared/Nancy%20Fresco/NPS/ARCN/

Readings (pt. 2)

- *Interior and Arctic Talking Points,* entire document online at *http://snap.uaf.edu/webshared/Nancy%20Fresco/NPS/ARCN/*

- *Beyond Naturalness* by David N. Cole and Laurie Yung, entire book, but with a focus on pp. 31-33. This section is available for preview on Google Books. *http://books.google.com/books?id=gfErgkCy0HkC&printsec=frontcover&cd=1&source=gbs_ViewAPI#v=onepage&q&f=false*



- *Interior Arctic Climate Drivers table* and Regional climate change summaries for ARCN parks online at *http://snap.uaf.edu/webshared/Nancy%20Fresco/NPS/ARCN/*

Corporations that derived value from scenarios

- **Shell:** pioneered the commercial use of scenarios; prepared for and navigated the oil crises of the 1970s, and the opening of the Russian market in the 1990s

- **Morgan Stanley Japan:** identified looming problems in Asian financial markets in the late 1990s. Held back on retail investments, and engaged fully with governments and regulators.

- **UPS:** in the late 1990s, used scenarios to identify and explore the powerful forces of globalization and consumer power. As a result, made significant investments (like Mail Boxes Etc) that enabled them to directly reach the end consumer.

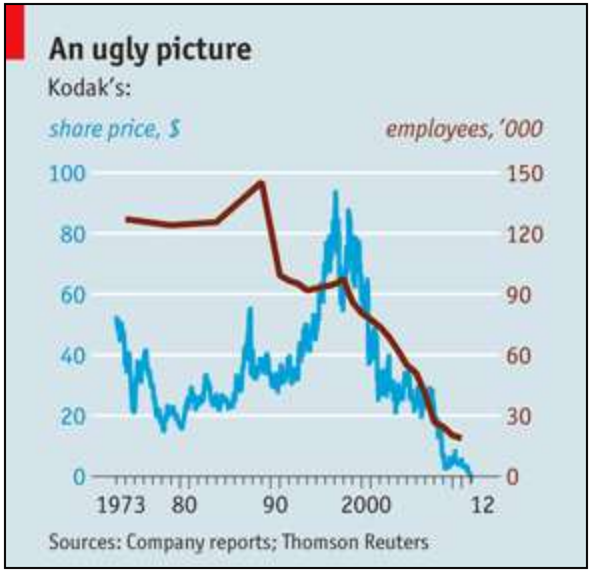
- **Microsoft:** Amidst great uncertainty, Microsoft used scenarios (including early indicators) to provide signals as to which platforms/technologies/channels would prevail.

One corporation that… didn't

Eastman Kodak

- Failure to diversify adequately
- Did not correctly read emerging markets
- Acted slowly, waiting for "perfect" products
- Complacency

http://www.economist.com/node/21542796



Climate Change in Alaska: the bottom line

alaskarenewableenergy.org

www.nenananewslink.com

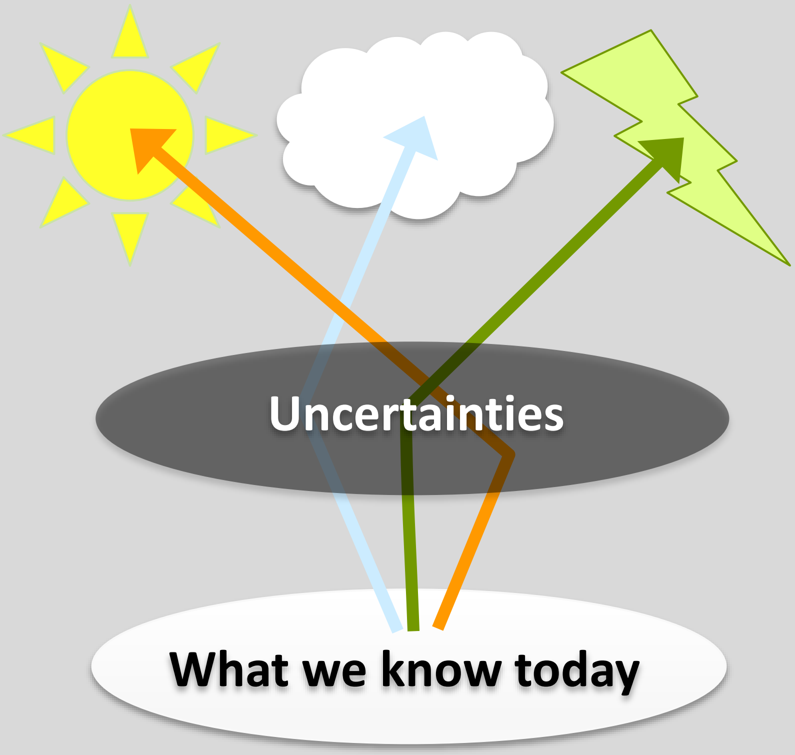
- Change is happening, and will continue for decades regardless of mitigation efforts.
- Key tipping points may be crossed, e.g fire, permafrost, sea ice, biome shift, glacial loss.
- High uncertainty results in divergent possible futures for many important variables.

Scenario Planning vs. Forecasting

- *Scenarios overcome the tendency to predict, allowing us to see multiple possibilities for the future*

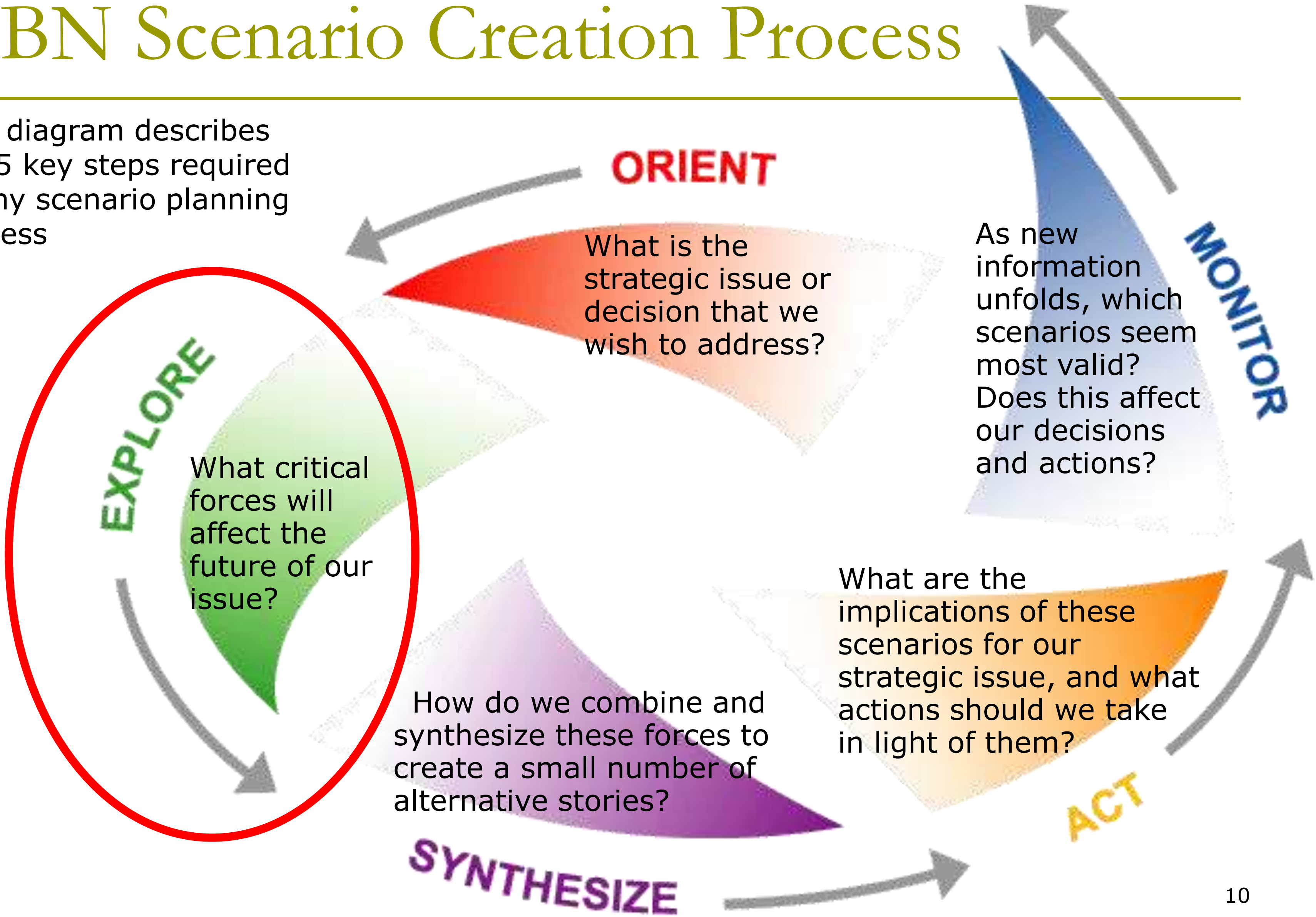
- Forecast Planning
  - One Future

- Scenario Planning
  - Multiple Futures



Explaining Scenarios: A Basic GBN Scenario Creation Process

This diagram describes the 5 key steps required in any scenario planning process



Step one: Orient

What is the strategic issue or decision that we wish to address?

How can NPS managers best preserve (*protect?*) the natural and cultural resources and values within their jurisdiction in the face of climate change?

Gates of the Arctic National Park
photo credits: Tom Moran, Jay Cable, Amy Marsh

To answer this challenge, we need to explore a broader question:

How will climate change effects impact the landscapes within which management units are placed over the next 50 to 100 years?

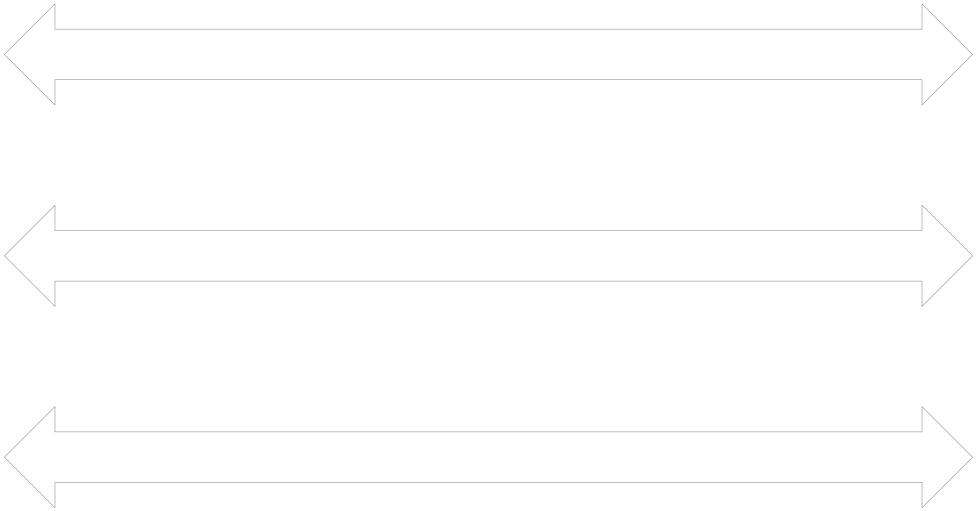
Step Two: Explore

What **critical forces** will affect the future of our issue?

CRITICAL UNCERTAINTIES

BIOREGION: _______________

Over the next 50 – 100 years, what will happen to . . . ?



Critical forces generally have unusually **high impact** and unusually **high uncertainty**

Selecting Drivers

What **critical forces** will affect the future of our issue?

CRITICAL UNCERTAINTIES

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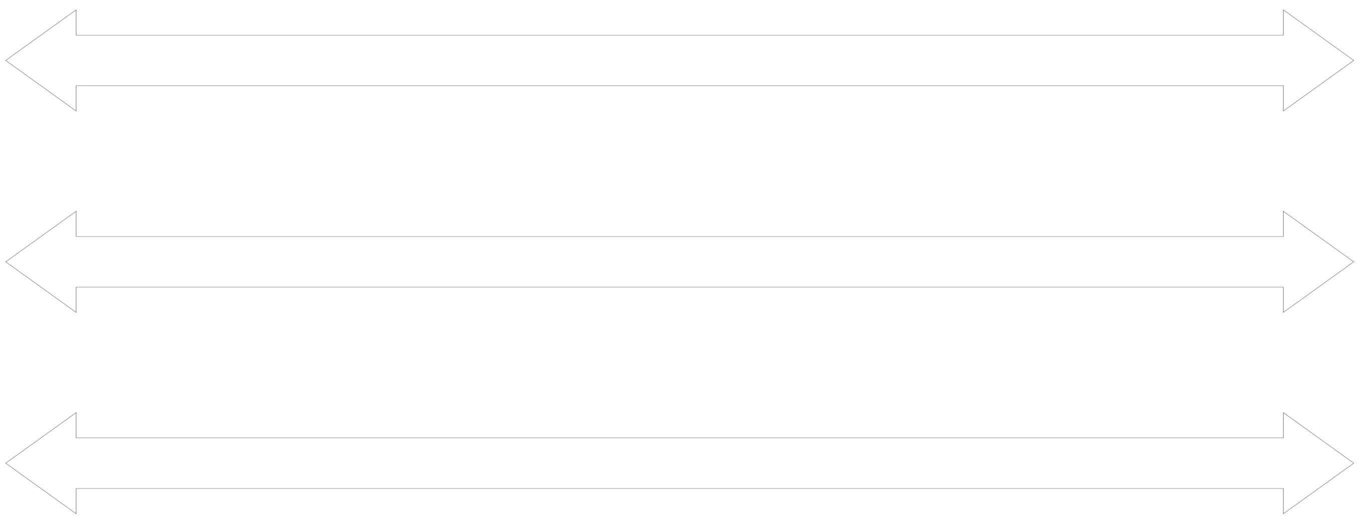
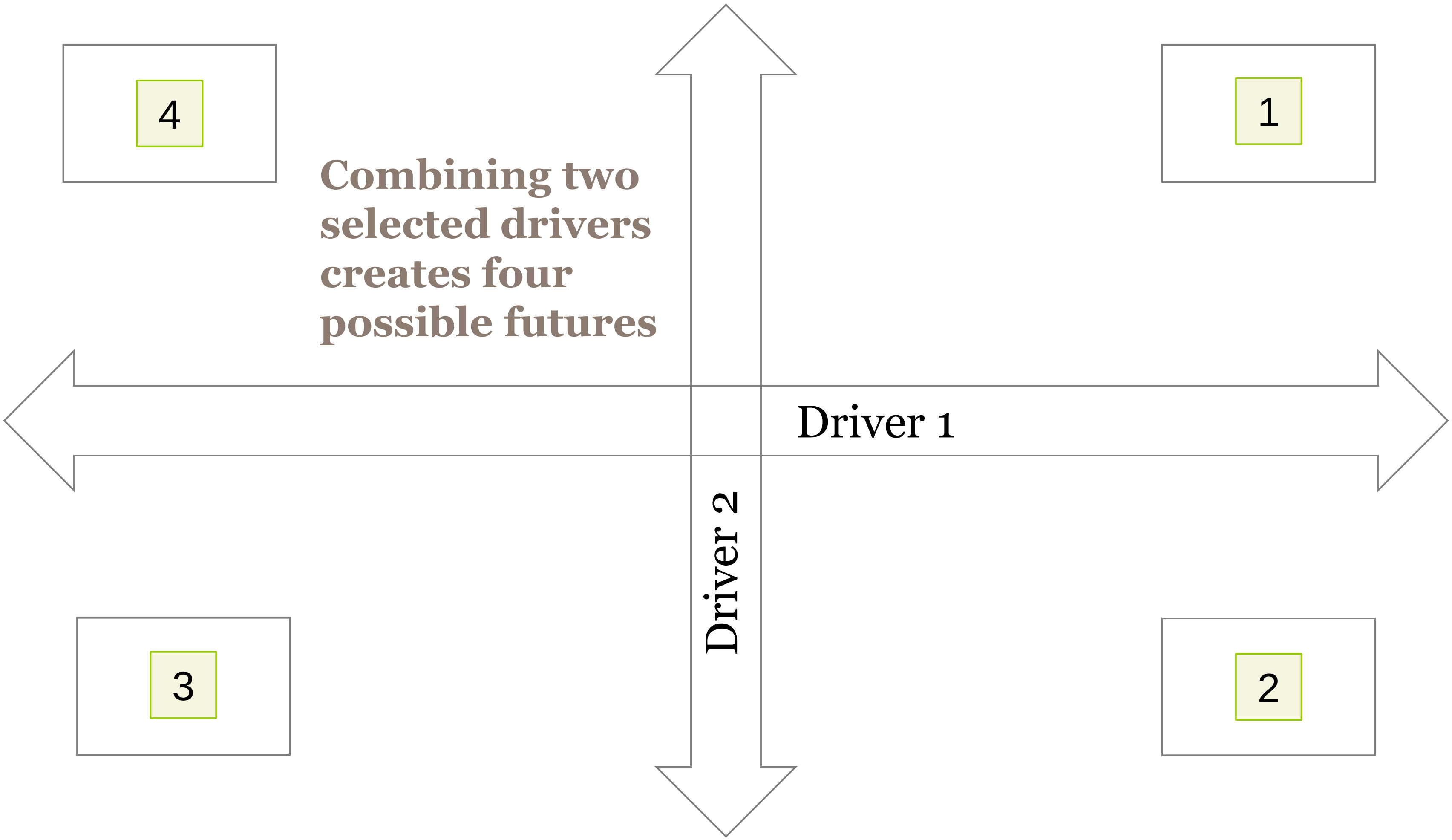


Selecting Drivers – Key points

- Drivers are the **critical forces** in our scenarios planning process.
- Critical forces generally have unusually **high impact** and unusually **high uncertainty**
- We are aiming to create scenarios that are:
  - **Challenging**
  - **Divergent**
  - **Plausible**
  - **Relevant**

CLIMATE SCENARIOS

BIOREGION: ______________



CLIMATE SCENARIOS

BIOREGION: _______________

Pick drivers with a wide range of possible outcomes

Choose drivers that impact several sectors, e.g tourism, subsistence, and wildlife, not just one

Select drivers with a high enough likelihood to be convincing to stakeholders

Select drivers with effects in most of the parks in the network

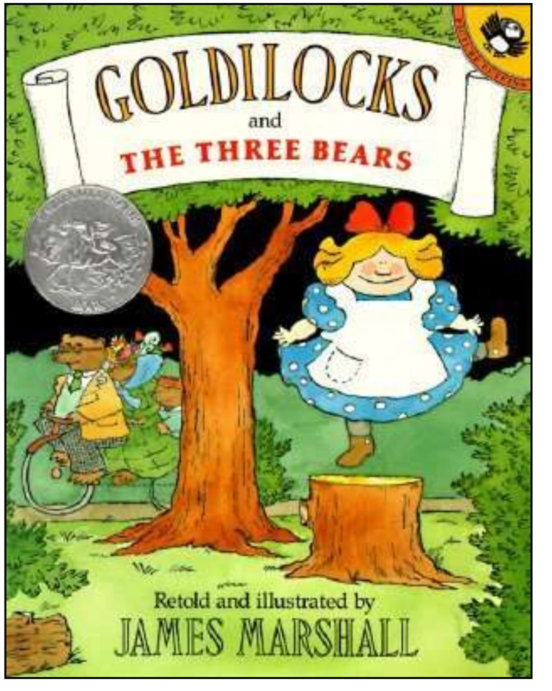
Avoid pairs of drivers that are too similar – think of the effects of crossing them with one another

Choose drivers that lead to the effects that are most critical

Keep in mind….

We will be synthesizing our results to create a small number of alternative stories

- Sixteen (or more) choices available (4x4)
- Need to select only 3-4 to turn into narratives and planning tools
- Focus on scenarios that are:
  - Challenging
  - Divergent
  - Relevant
  - Plausible
- Create a narrative (story) about each scenario



Keep in mind…

Name	Species	Hair/Fur	Age	Appetite Level	Size	Preliminary Porridge Assessment	Preliminary Mattress Assessment
Goldilocks	Human	Blonde	8	Moderate	Petite	N/A	N/A
Papa	Bear	Brown	12	High	Big	Too Hot	Too Hard
Mama	Bear	Tawny	11	Moderate	Medium	Too Cold	Too Soft
Baby	Bear	Red-Brown	3	Low	Small	Just Right	Just Right

Effective storytelling matters!

Climate Change Scenario Drivers

TEMPERATURE AND LINKED VARIABLES:

thaw, freeze, season length, extreme days, permafrost, ice, freshwater temperature

PRECIPITATION AND LINKED VARIABLES:

rain, snow, water availability, storms and flooding, humidity

PACIFIC DECADAL OSCILLATION (PDO):

definition, effects, and predictability

SEA LEVEL:

erosion also linked to sea ice and storms

OCEAN ACIDIFICATION

Arctic Park Units

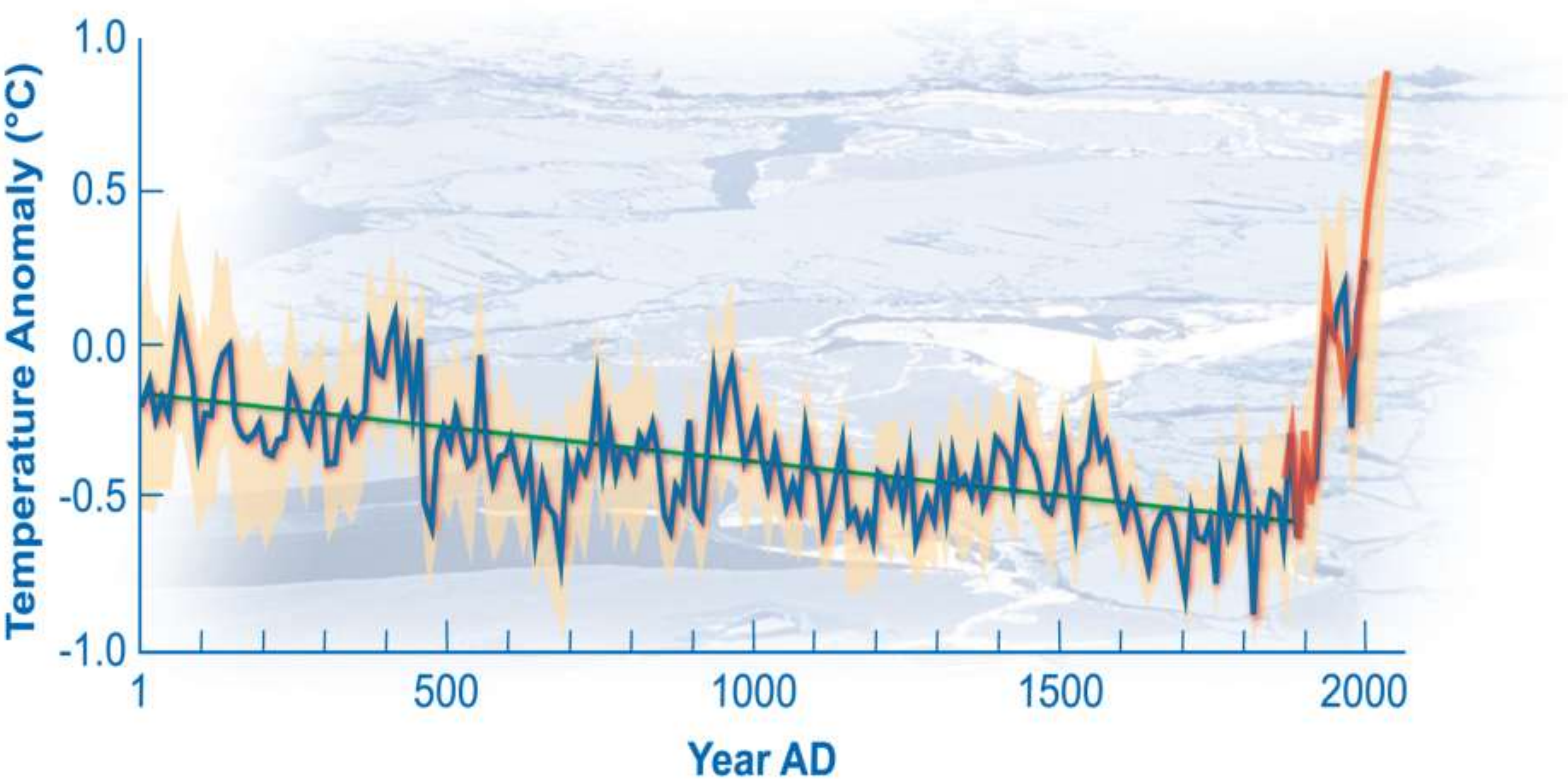
Climate Variable	Projected Change by 2050	Projected Change by 2100	Patterns of Change	Confidence	Source
Temperature	+2.5°C ±1.5°C	+5°C ±2°C	More pronounced in N and autumn-winter	>95% for increase	IPCC (2007); SNAP/UAF
Precipitation (rain and snow)	Winter snowfall Autumn rain and snow	Winter snowfall Autumn rain and snow	Increased % falls as rain in shoulder seasons	High uncertainty in timing of snow onset and melt	AMAP/SWIPA; SNAP/UAF
Freeze-up Date	5-10 days later	10-20 days later	Largest change near coast	>90%	SNAP/UAF
Length of Ice-free Season (rivers, lakes)	↑ 7-10 days	↑ 14-21 days	Largest change near coast	>90%	IPCC (2007); SNAP/UAF
Length of Growing Season	↑ 10–20 days	↑ 20–40 days	Largest change near coast	>90%	IPCC (2007); SNAP/UAF
River and Stream Temps	↑ 1–3°C	↑ 2–4°C	Earlier breakup, higher summer temps	>90%	Kyle & Brabets (2001)
Water Availability	↓ 0–20%	↓ 10–40%	Longer summer, thicker active layer	>66% varies by region	SNAP/UAF; Wilderness Society
Relative Humidity	0% ±10% ↑ or ↓	0% ±15% ↑ or ↓	Absolute humidity increases	50% *as likely as not*	SNAP/UAF
Wind Speed	↑ 2–4%	↑ 4–8%	More pronounced in winter & spring	>90% for increase	Abatzoglou & Brown
PDO	Uncertain	Uncertain	Major effect on Alaska temps in cold season	High degree of natural variation	Hartmann & Wendler (2005)
Extreme Events: Temperature	3-6x more warm events; 3-5x fewer cold events	5-8x more warm events; 8-12x fewer cold events	↑ warm events, ↓ cold events	>95% likely	Abatzoglou & Brown; Timlin & Walsh (2007)
Extreme Events: Precipitation	Change of –20% to +50%	Change of –20% to +50%	↑ winter ↓ spring	*Uncertain*	Abatzoglou & Brown
Extreme Events: Storms	↑ frequency/intensity	↑ frequency/intensity	Increase	>66%	Loehman (2011)

Climatic drivers of Alaskan change

- Earth/sun orbital variations (10,000+ yrs)
- Greenhouse gas, aerosol forcing (10s-100 yrs)
- Internal variability (1-10s yrs)
  (e.g., Pacific Decadal Oscillation, Arctic Oscillation)
- Internal feedbacks (land surface, sea ice,…)

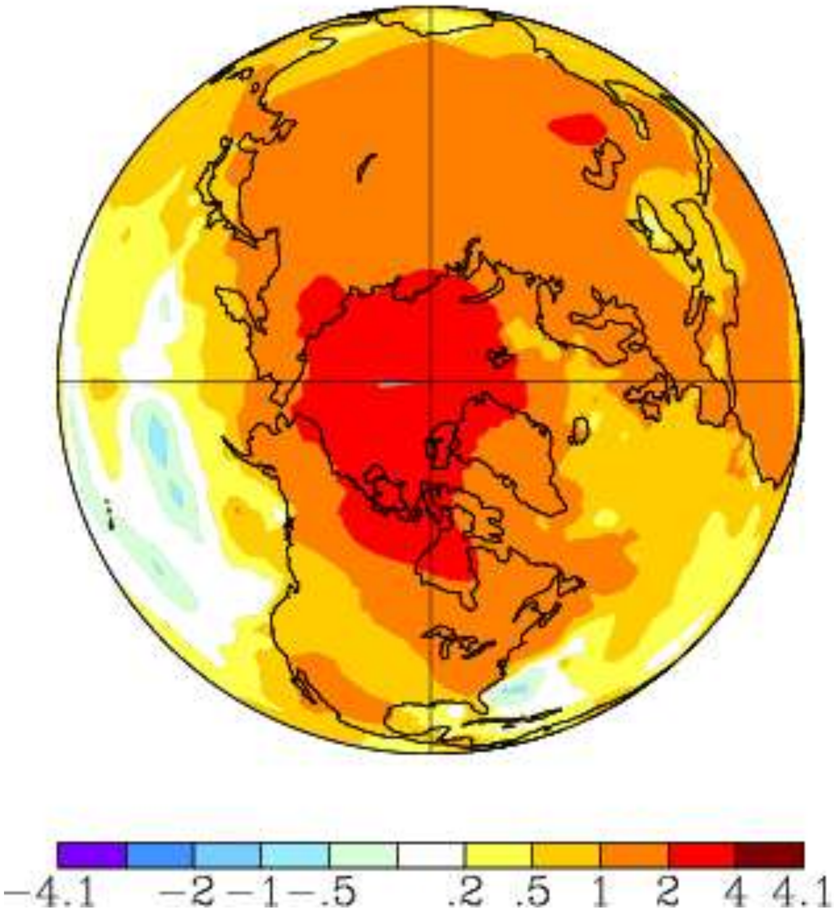
Reconstruction of summer Arctic temperatures

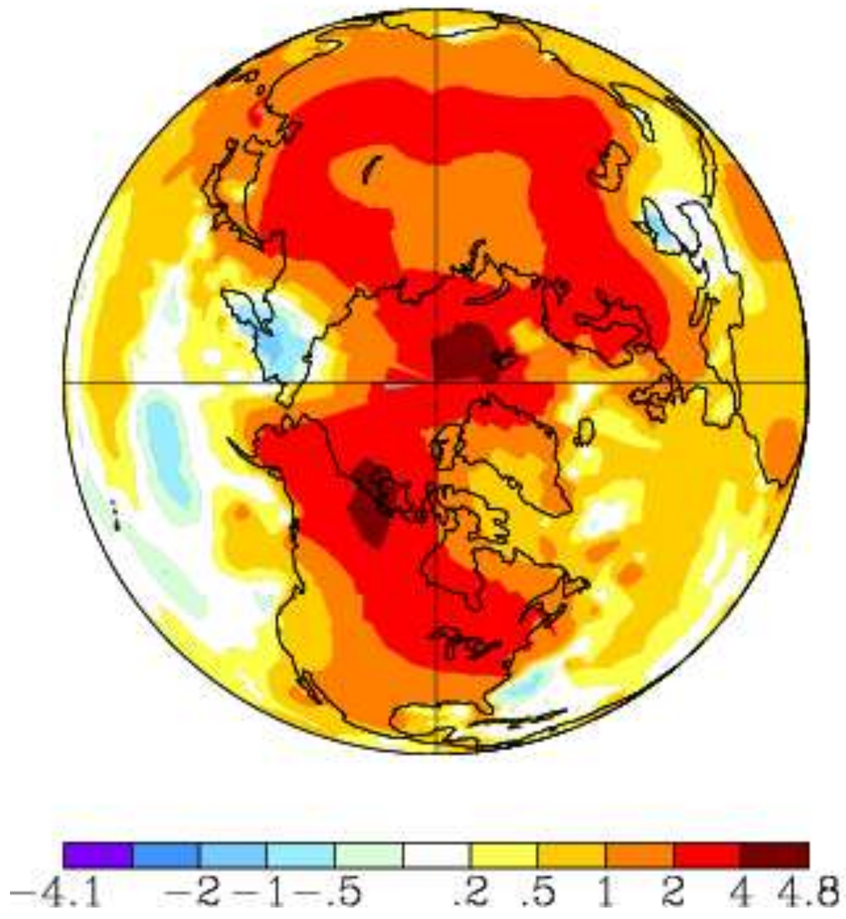
[Kaufman et al., 2009, Science]



Change in Arctic surface air temperature (°C), 1961-2010
[from NASA GISS]

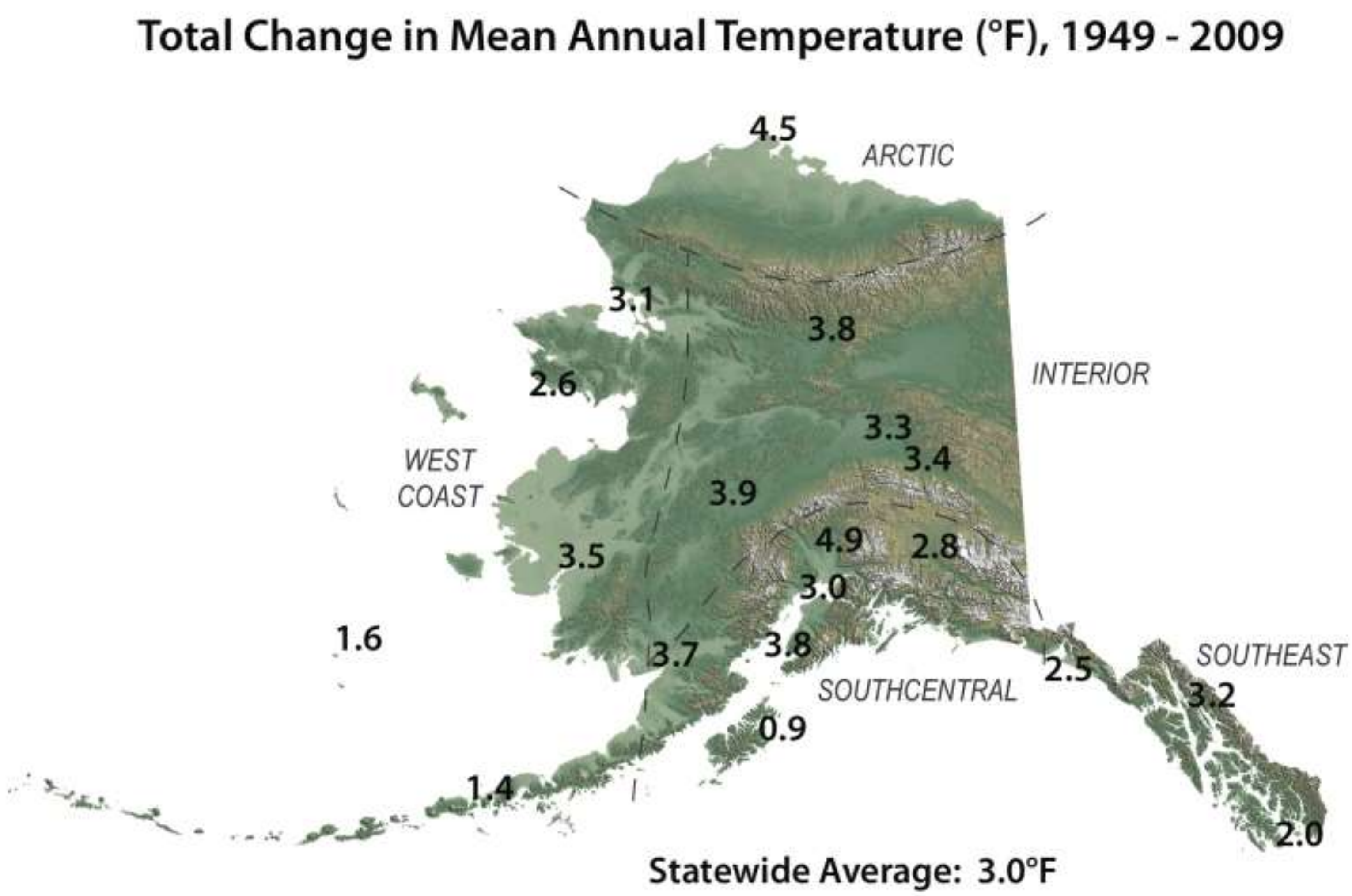
Annual **Winter**





The attribution issue: Temperature change in Alaska, 1949-2009

[from Alaska Climate Research Center]



Temperature changes (°F) in Alaska: 1949-2009

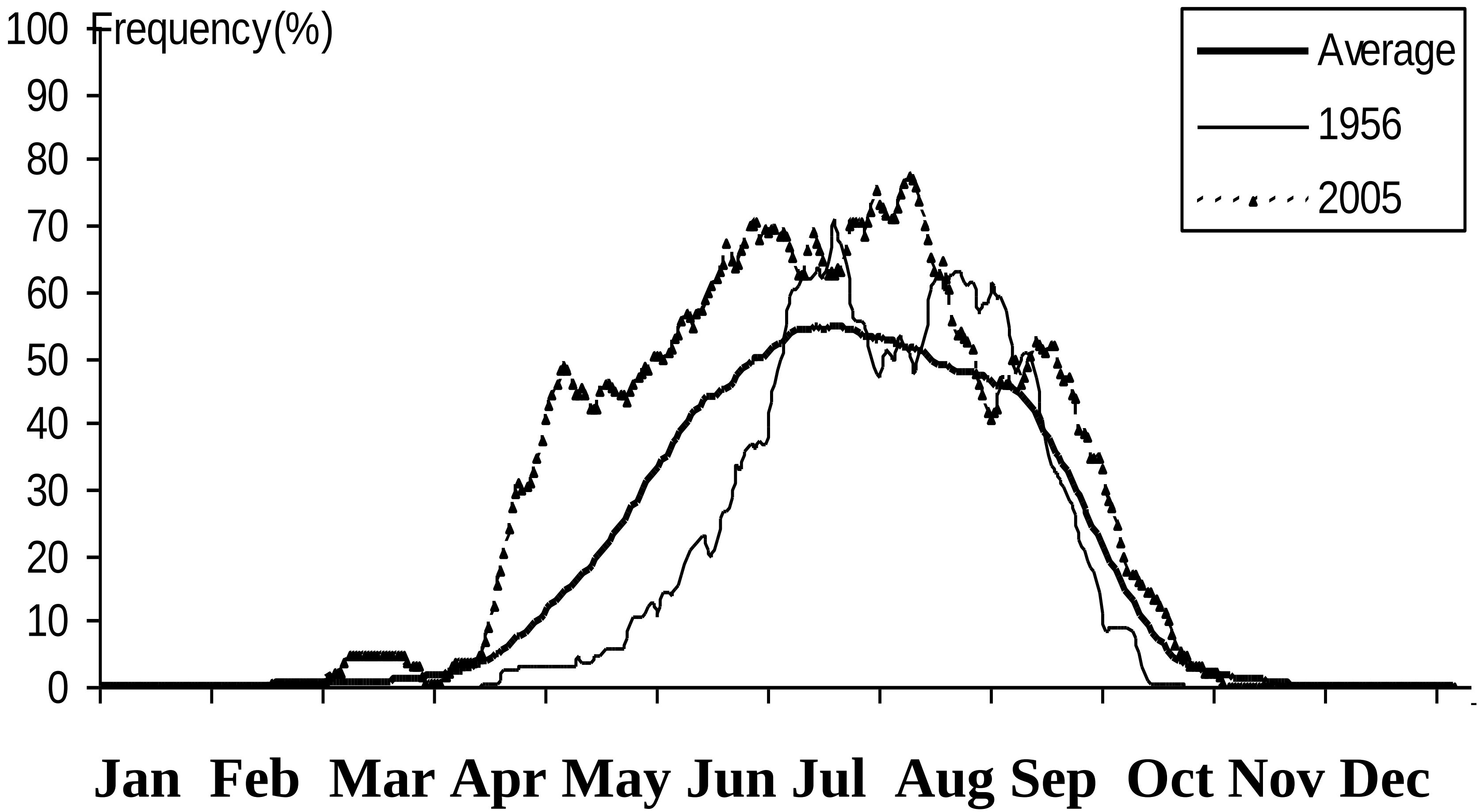
Total Change in Mean Seasonal and Annual Temperature (°F), 1949 - 2009

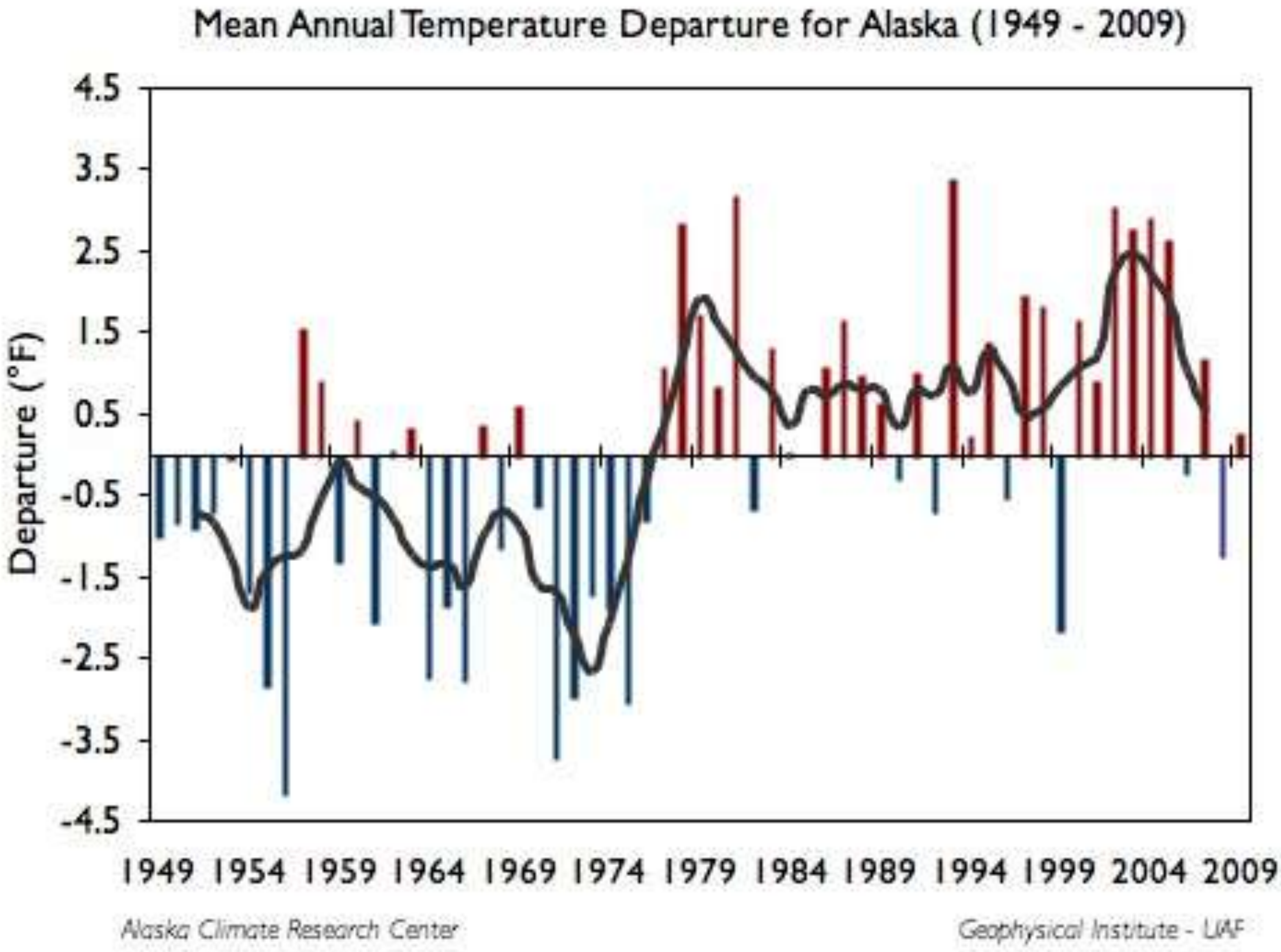
Region	Location	Winter	Spring	Summer	Autumn	Annual
Arctic	Barrow	6.7	4.5	3.0	3.7	4.5
Interior	Bettles	8.1	4.3	1.8	1.1	3.8
	Big Delta	8.9	3.4	1.2	0.0	3.4
	Fairbanks	7.4	3.6	2.3	-0.2	3.3
	McGrath	7.4	4.6	2.7	0.8	3.9
West Coast	Kotzebue	6.3	1.8	2.6	1.4	3.1
	Nome	4.2	3.3	2.5	0.4	2.6
	Bethel	6.6	4.8	2.3	0.0	3.5
	King Salmon	7.9	4.5	1.7	0.6	3.7
	Cold Bay	1.5	1.6	1.7	0.8	1.4
	St Paul	0.8	2.1	2.6	1.1	1.6
Southcentral	Anchorage	5.8	3.3	1.6	1.5	3.0
	Talkeetna	8.4	5.2	3.1	2.4	4.9
	Gulkana	7.7	2.4	1.0	0.1	2.8
	Homer	5.9	3.8	3.3	1.8	3.8
	Kodiak	0.7	2.1	1.2	-0.4	0.9
Southeast	Yakutat	4.6	2.8	1.8	0.4	2.5
	Juneau	6.2	2.9	2.2	1.4	3.2
	Annette	3.4	2.3	1.8	0.3	2.0
	Average	5.7	3.3	2.1	0.9	3.0

Alaska Climate Research Center

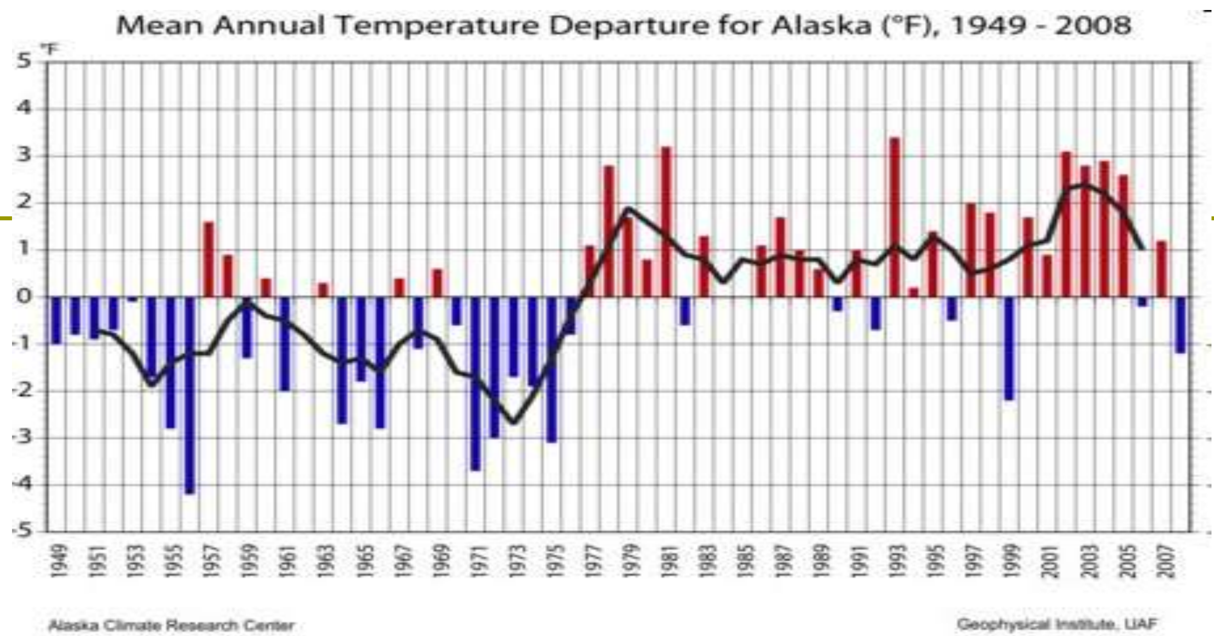
Geophysical Institute, University of Alaska Fairbanks

Seasonal frequency of weather conducive to sightseeing (King Salmon, AK)

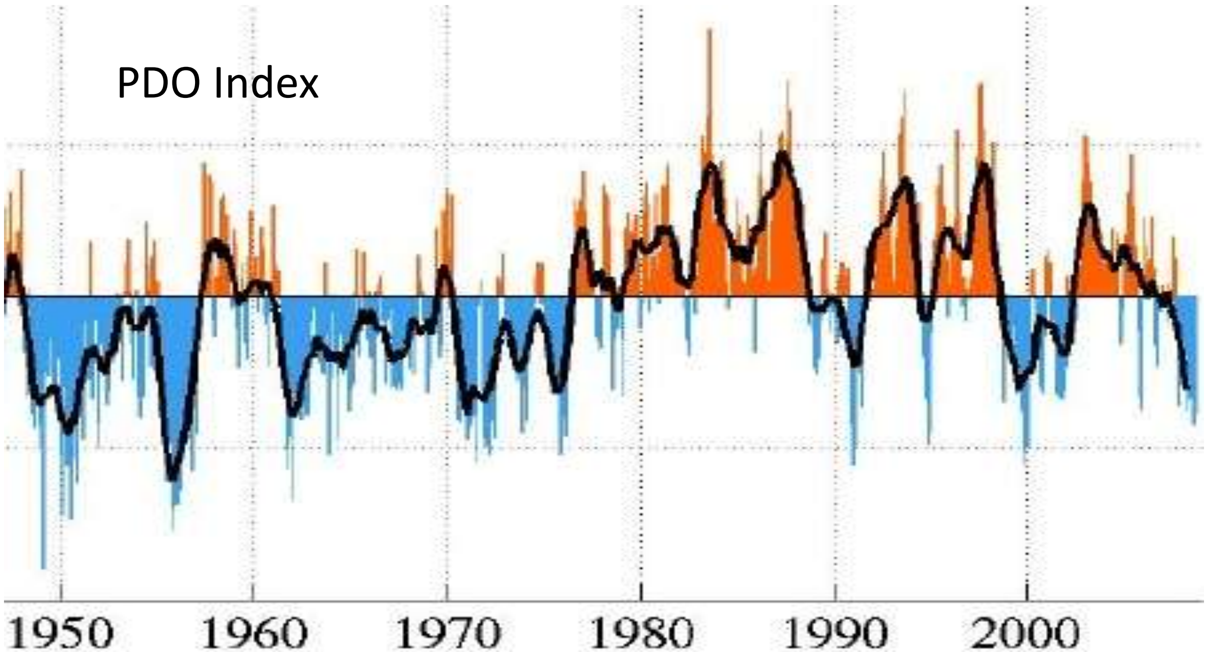




(from Alaska Climate Research Center)



Alaska annual temperature anomalies

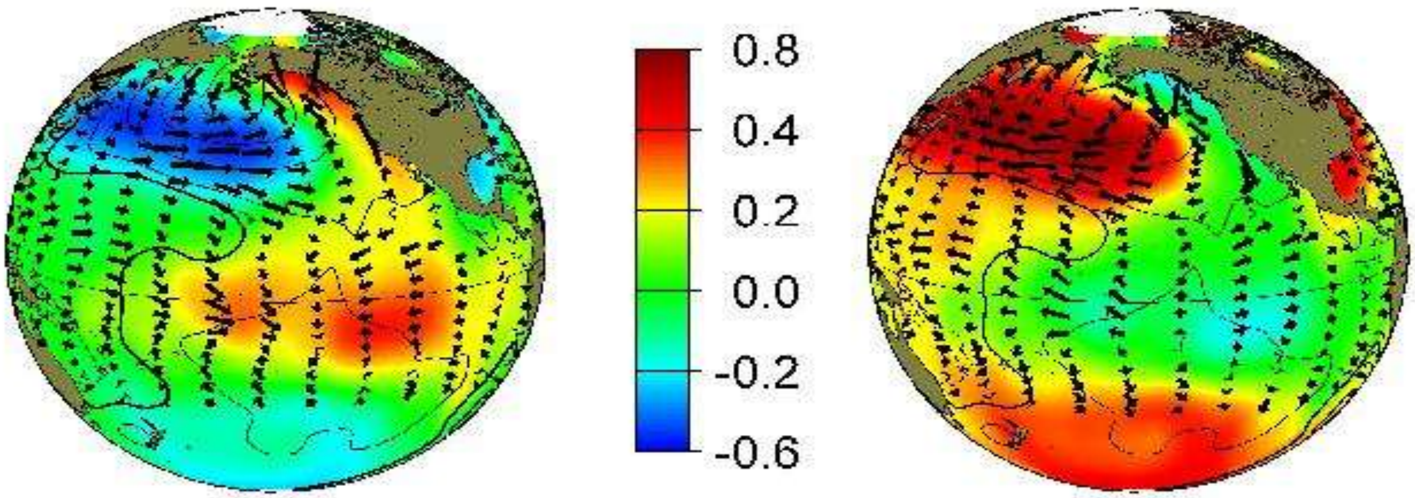


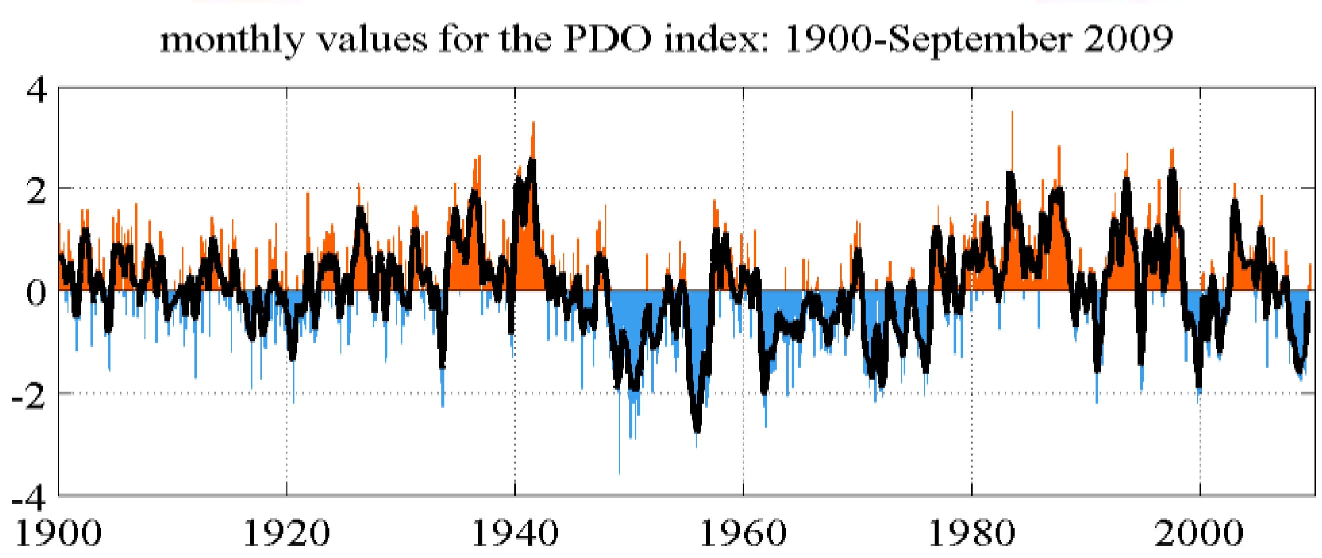
Pacific Decadal Oscillation Index

The Pacific Decadal Oscillation

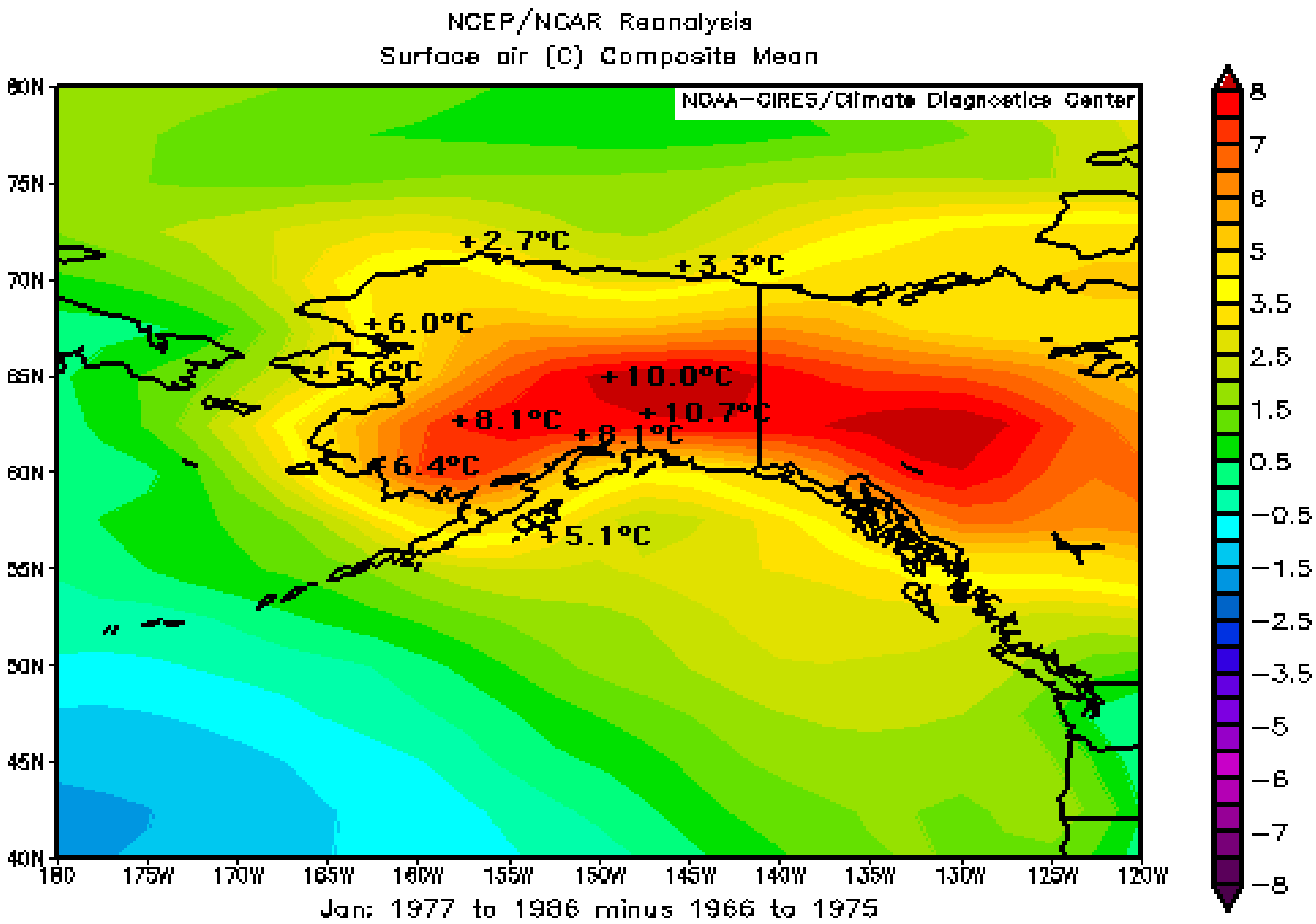
[from JISAO, Univ. Of Washington]

Alaska warm phase | Alaska cold phase



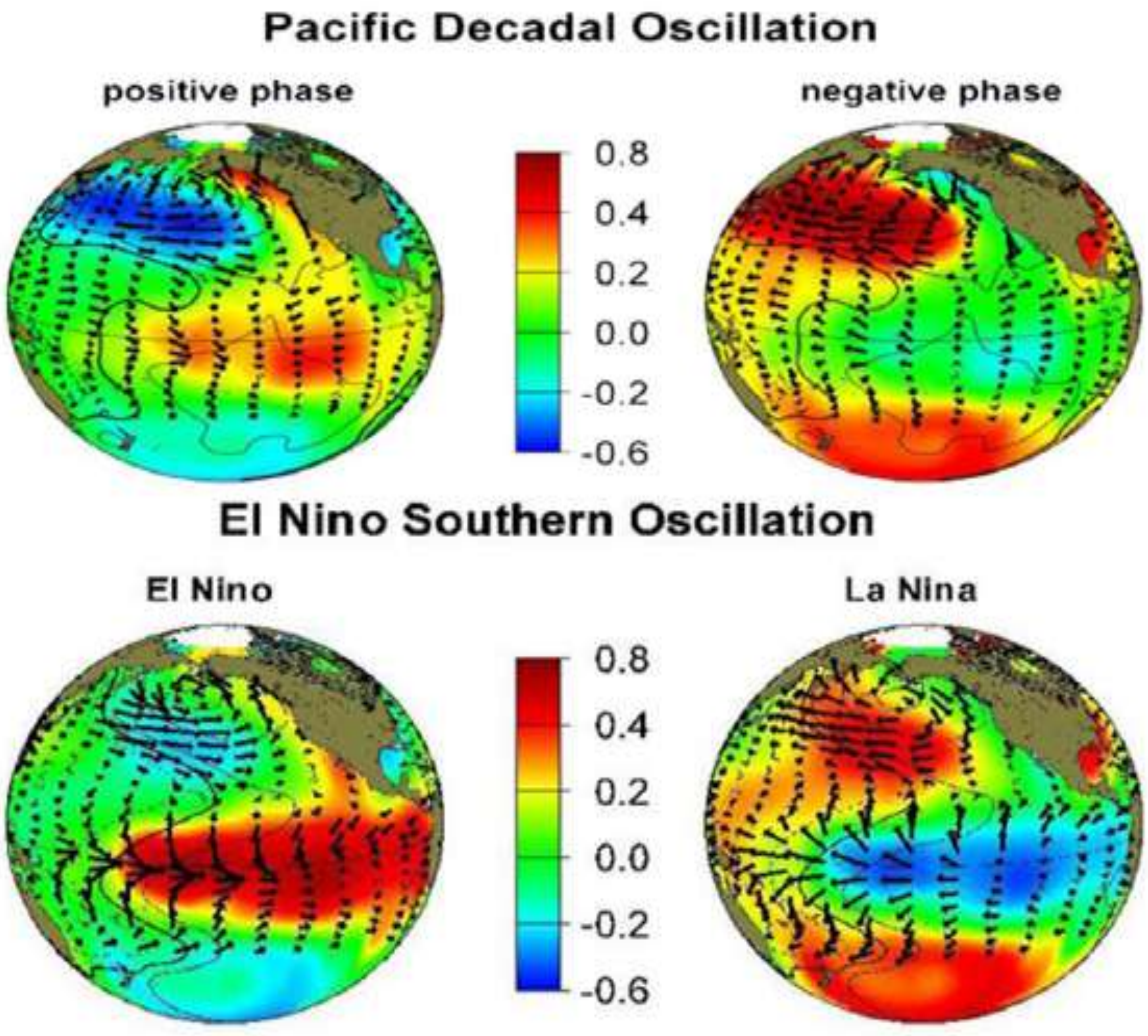


Effect of Pacific Decadal Oscillation shift (1976) on Alaskan temperature anomalies (°C) *in January*: 1977-86 minus 1966-75



From B. Hartmann and G. Wendler, 2003
Alaska Climate Research Center

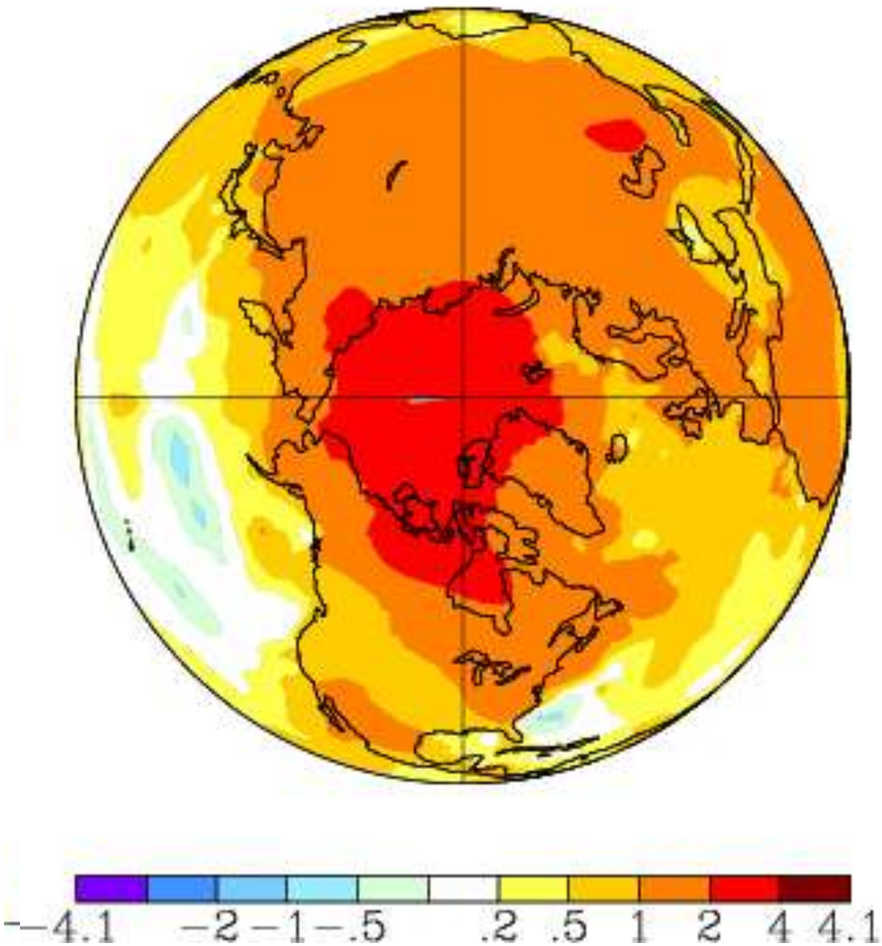
The PDO has a major influence on Alaskan and for that matter global temperatures. The positive phase favors more El Ninos and a stronger Aleutian low and warm water in the north Pacific off the Alaskan coast. The negative phase more La Ninas and cold eastern Gulf of Alaska waters. Note the strong similarity of the positive phase with El Nino and the negative with La Nina.

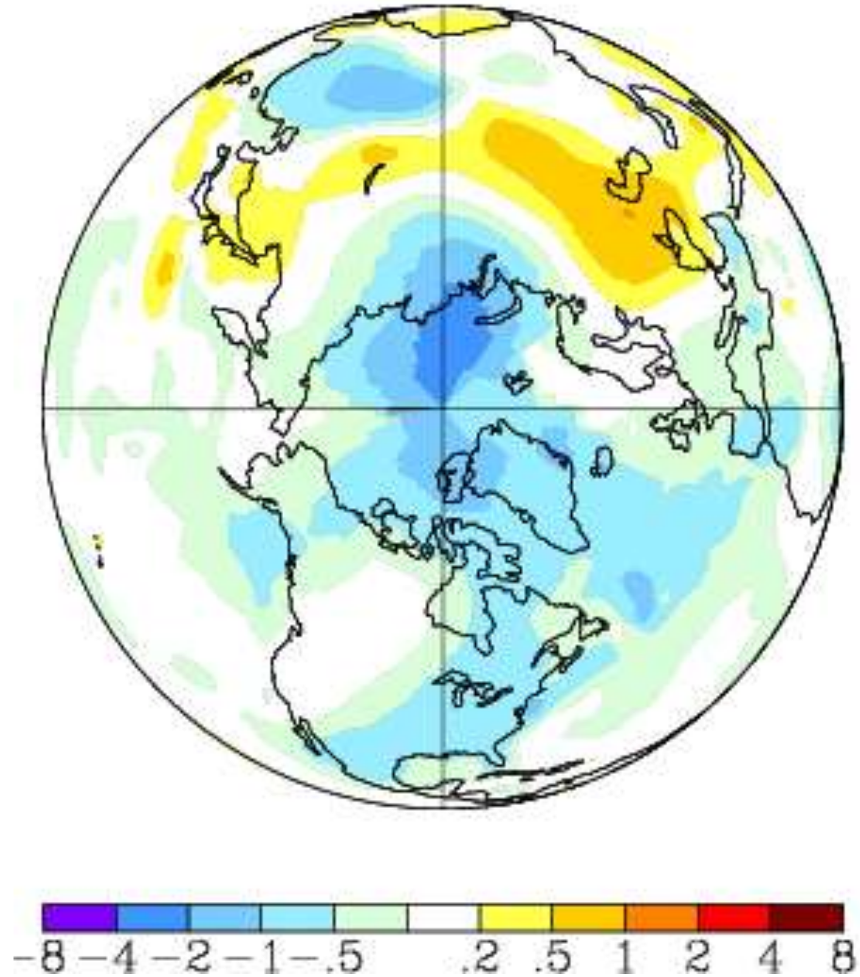


[from NASA GISS]

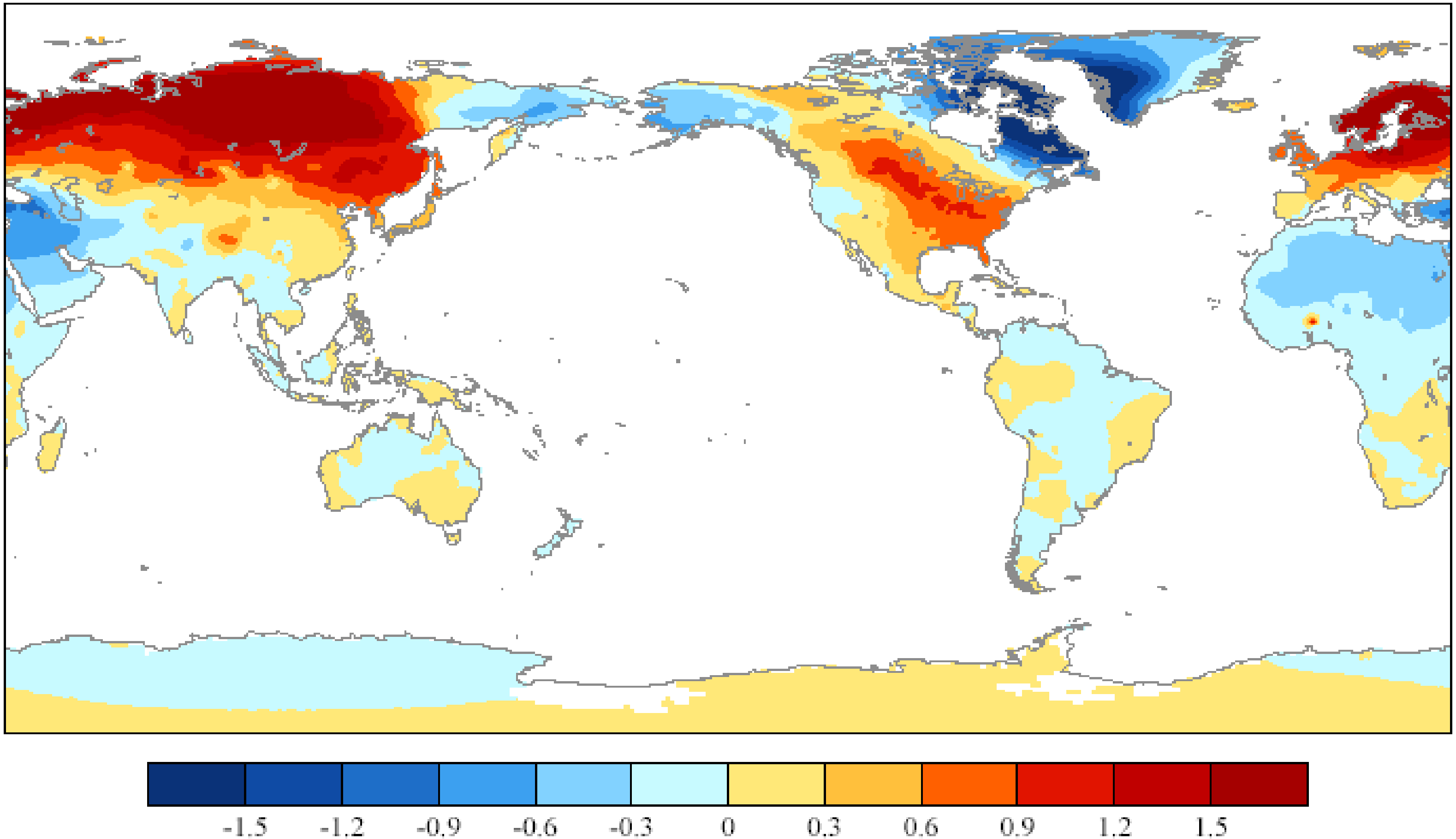
1961-2010

1941-1980





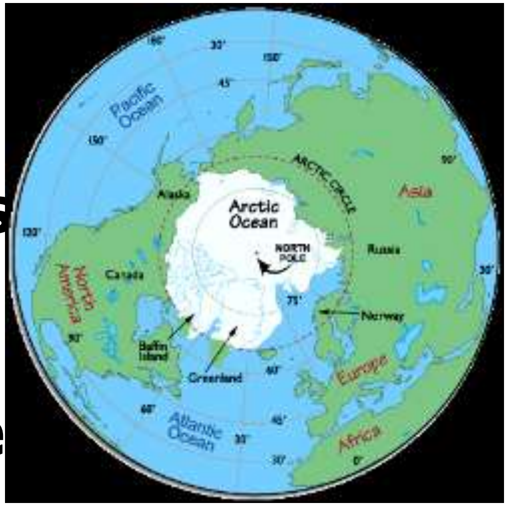
Arctic Oscillation's contribution to recent winter temperature changes (from D. Thompson)



Projections based on IPCC models

- A set of 15 models compared with data (1958-2000) for surface air temperature, sea level pressure, and precipitation

- Root-mean-square error (RMSE) evaluated over seasonal cycle to s the 5 best-performing models for

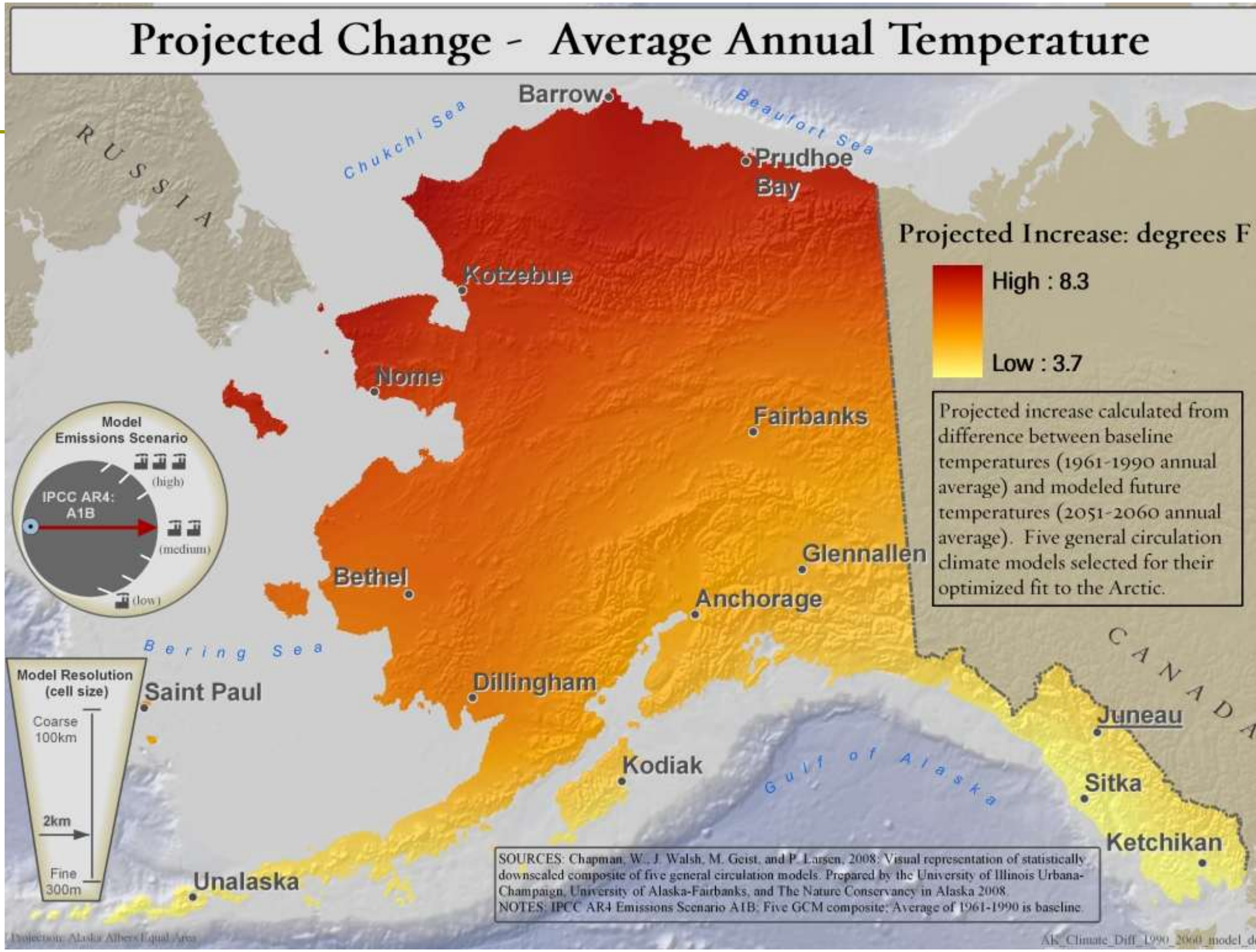


- First focused on A1B (intermediate scenario, then added B1 and A2

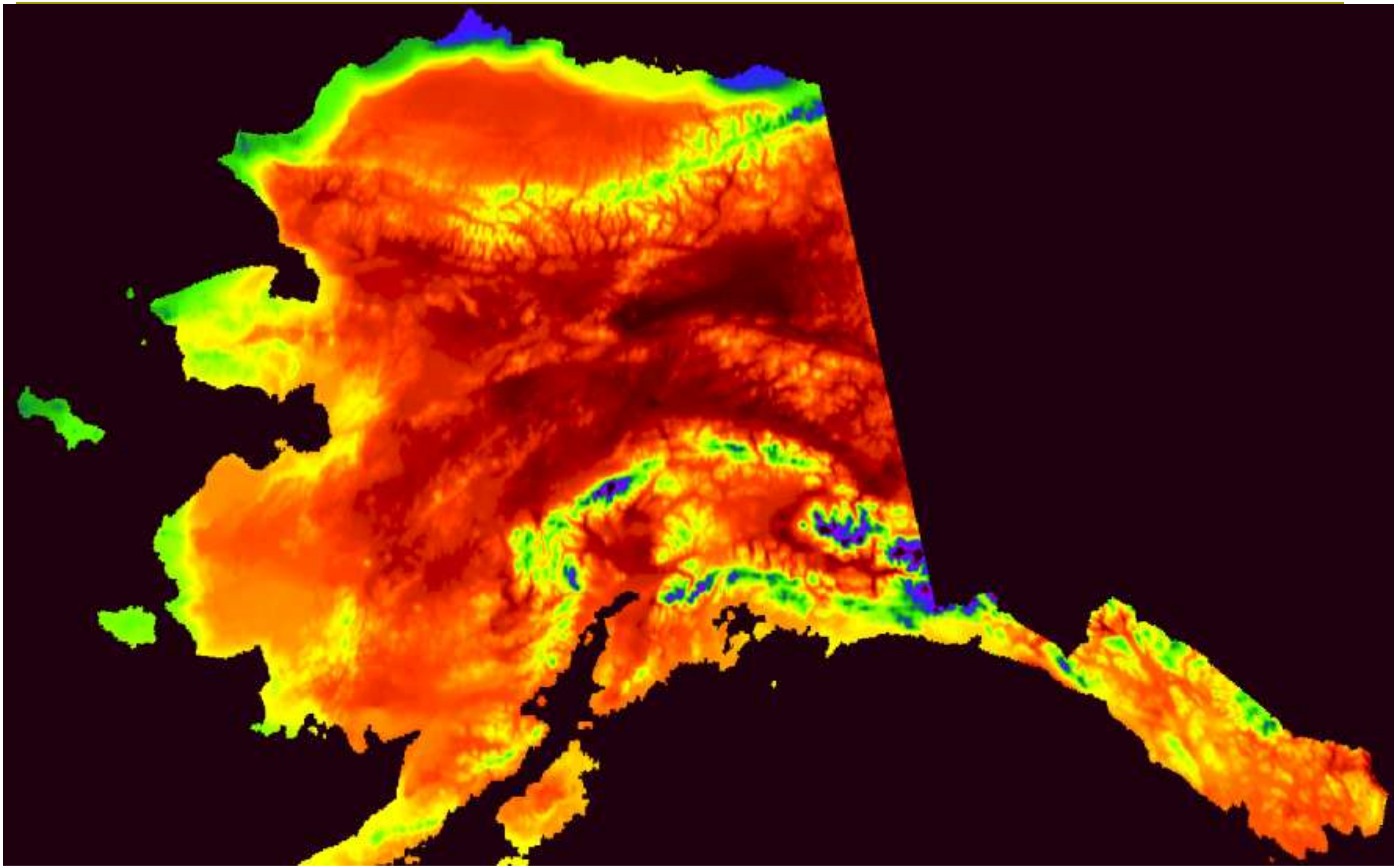
- Downscaled coarse-resolution GCM output to 2 km, now to 800 m

Downscaling by the "Delta" method

- **A high-resolution climatology for a known reference period provides the base map**
- **A coarse-resolution climate model's future changes from the model's climatology for the same reference period is evaluated $\Rightarrow$ the model's "delta"**
- **The model's delta is added to the high-resolution base map for the reference period**
- **Key point: Superimposed "delta" field is coarse, i.e., smooth; underlying climatology's base map provides the spatial detail**

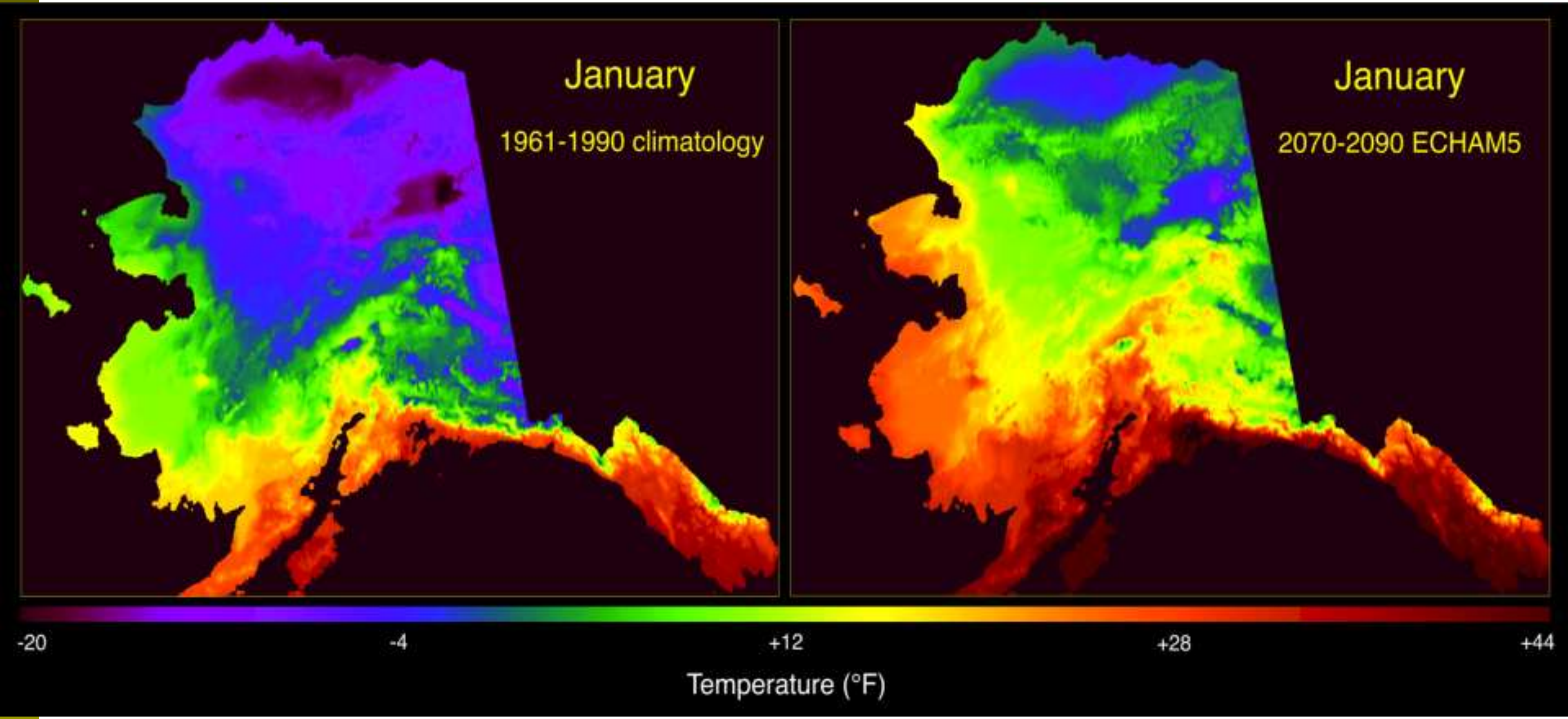

Projected Change - Average Annual Temperature
Barrow
Chukchi Sea
Beaufort Sea
Prudhoe Bay
RUSSIA
Kotzebue
Nome
Fairbanks
Glennallen
Bethel
Anchorage
Dillingham
Kodiak
Bering Sea
Gulf of Alaska
Saint Paul
Unalaska
Juneau
Sitka
Ketchikan
CANADA
Projected Increase: degrees F
High : 8.3
Low : 3.7
Projected increase calculated from difference between baseline temperatures (1961-1990 annual average) and modeled future temperatures (2051-2060 annual average). Five general circulation climate models selected for their optimized fit to the Arctic.
Model Emissions Scenario
IPCC AR4: A1B
(high)
(medium)
(low)
Model Resolution (cell size)
Coarse 100km
2km
Fine 300m
SOURCES: Chapman, W., J. Walsh, M. Geist, and P. Larsen, 2008: Visual representation of statistically downscaled composite of five general circulation models. Prepared by the University of Illinois Urbana-Champaign, University of Alaska-Fairbanks, and The Nature Conservancy in Alaska 2008.
NOTES: IPCC AR4 Emissions Scenario A1B; Five GCM composite; Average of 1961-1990 is baseline.

PRISM July T_{max} (1961-1990) (deep red = 70s °F, blue = 40s °F)

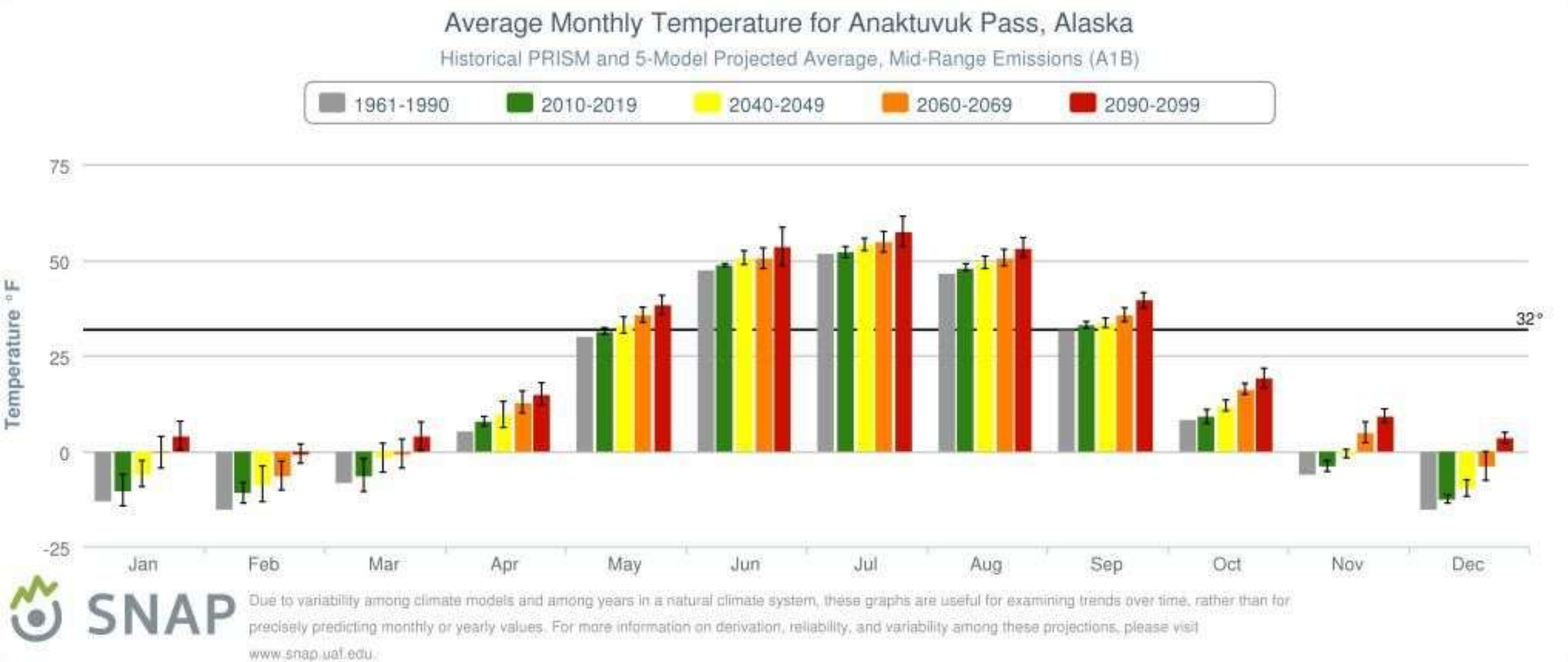


January Temperatures

1961-1990 (PRISM climatology) 2070-2090 (ECHAM5)



Monthly temperature projections for Anaktuvuk Pass A1B (mid-range) scenario



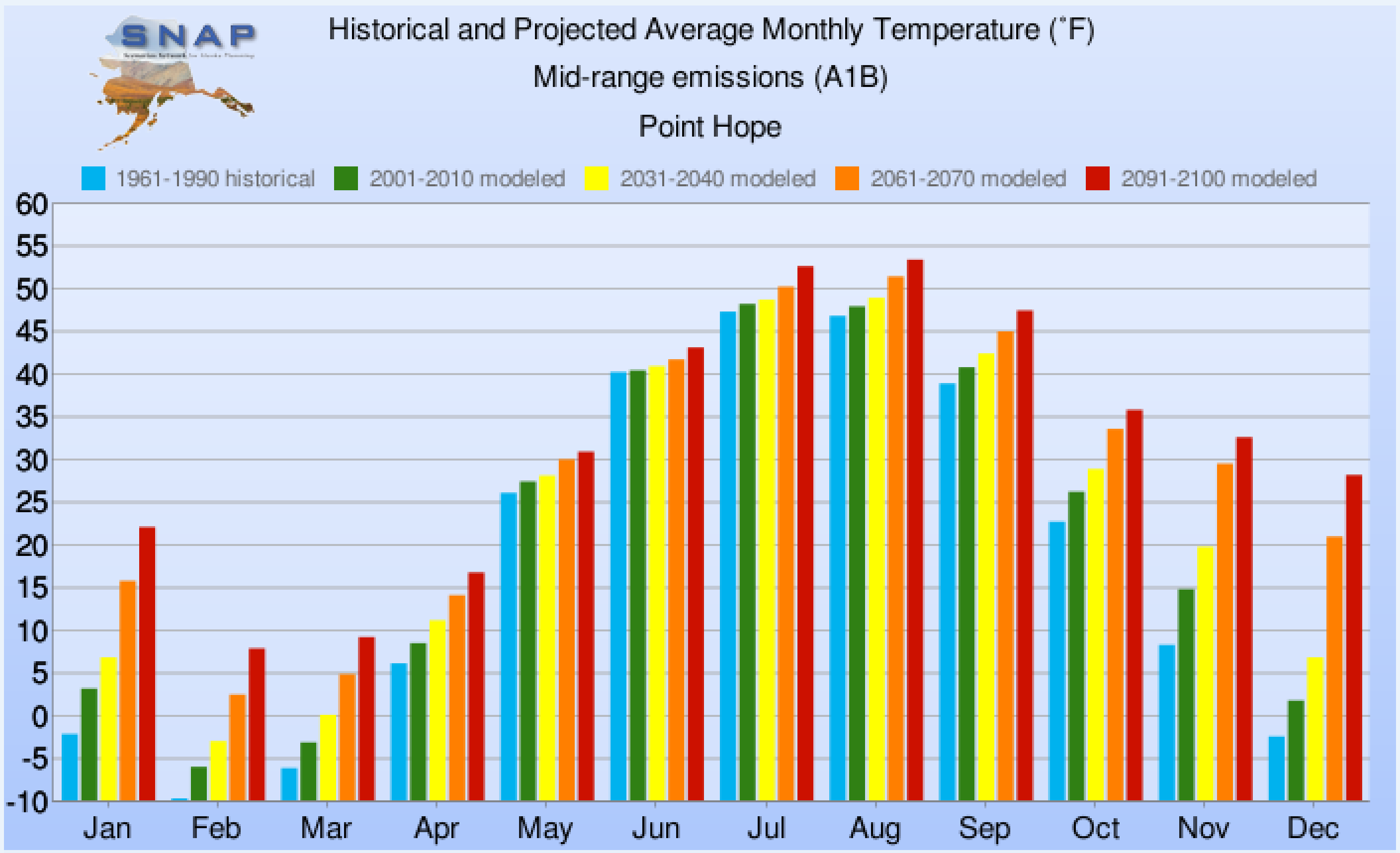
Temperature | Precipitation

www.snap.uaf.edu

Future Greenhouse Gas Emissions:

Low | **Medium** | High

Details
Print
Download



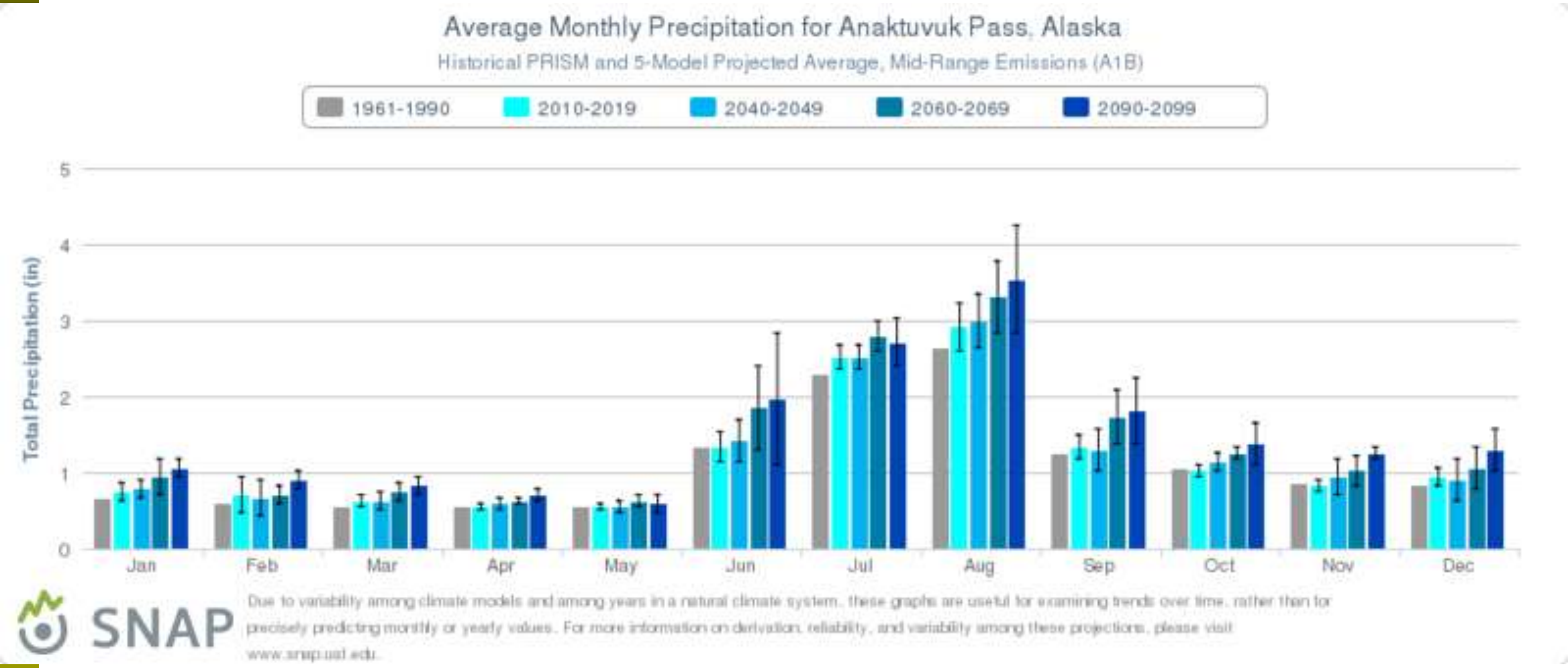
This graph shows average values from projections from five global climate models used by the Intergovernmental Panel on Climate Change. Due to variability among models and among years in a natural climate system, such graphs are useful for examining trends over time, rather than for precisely predicting monthly or yearly values. For more information on the SNAP program, including derivation, reliability, and variability among these projections, please visit www.snap.uaf.edu.

Sample of projections (A1B scenario): Fort Yukon temperatures by decade

FORT-YUKON 66.5647 66.5681 214.7261 214.7170 0.520 KM

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1961-1990	-20.3 (0.0)	-15.0 (0.0)	0.6 (0.0)	21.5 (0.0)	45.0 (0.0)	60.3 (0.0)	63.2 (0.0)	56.5 (0.0)	41.3 (0.0)	19.0 (0.0)	-7.3 (0.0)	-18.0 (0.0)
1991-2000	-17.9 (3.5)	-13.7 (1.2)	4.9 (2.1)	23.6 (3.3)	46.2 (1.4)	61.1 (1.3)	63.8 (0.7)	58.1 (0.4)	42.1 (1.1)	19.8 (0.9)	-5.2 (1.8)	-16.6 (2.8)
2001-2010	-16.4 (3.2)	-11.2 (3.7)	4.0 (1.6)	24.5 (2.1)	47.3 (1.9)	60.7 (1.3)	64.8 (1.7)	58.2 (1.0)	42.3 (1.0)	21.0 (1.7)	-4.2 (1.5)	-16.8 (2.3)
2011-2020	-16.0 (3.3)	-11.6 (2.3)	3.8 (4.0)	24.1 (2.1)	46.6 (0.9)	62.1 (1.3)	63.3 (1.5)	58.0 (1.1)	43.1 (1.0)	20.3 (2.1)	-4.6 (1.3)	-15.4 (2.0)
2021-2030	-12.9 (5.4)	-7.2 (3.6)	6.0 (2.3)	25.0 (3.2)	46.8 (0.6)	61.7 (1.5)	63.8 (1.7)	58.7 (1.8)	42.5 (1.1)	21.7 (2.4)	-3.9 (1.8)	-13.4 (2.9)
2031-2040	-13.3 (1.5)	-9.2 (4.5)	5.8 (4.1)	25.9 (2.6)	47.5 (1.5)	62.3 (1.3)	65.1 (2.5)	59.3 (2.0)	43.4 (1.4)	23.5 (2.4)	-0.1 (1.7)	-12.9 (2.4)
2041-2050	-10.9 (3.5)	-6.8 (3.7)	11.1 (3.2)	25.6 (3.0)	48.8 (2.1)	63.0 (1.9)	66.0 (1.7)	60.1 (1.5)	45.5 (2.1)	26.0 (2.0)	2.3 (1.5)	-9.3 (2.8)
2051-2060	-10.9 (4.3)	-4.5 (6.4)	7.5 (2.4)	27.2 (3.2)	48.4 (0.8)	63.8 (1.8)	66.5 (1.7)	60.5 (2.0)	45.1 (1.7)	25.4 (1.4)	1.8 (1.0)	-7.1 (2.1)
2061-2070	-6.8 (2.0)	-3.8 (3.6)	10.4 (4.2)	29.3 (3.1)	50.9 (2.5)	64.4 (3.4)	67.3 (3.1)	61.5 (2.3)	46.2 (2.4)	27.3 (2.1)	5.2 (3.1)	-6.0 (4.6)
2071-2080	- 6.4 (1.9)	-3.4 (3.9)	10.8 (2.0)	29.3 (3.8)	51.3 (3.0)	64.3 (3.6)	67.7 (3.2)	62.7 (2.4)	46.9 (1.7)	27.8 (2.7)	5.3 (3.7)	-4.3 (3.9)
2081-2090	-3.8 (1.6)	-0.6 (3.3)	11.4 (3.6)	30.4 (3.6)	51.5 (2.3)	65.4 (3.5)	68.3 (2.2)	63.2 (2.6)	46.8 (1.7)	29.0 (1.2)	7.2 (2.6)	-2.7 (3.8)
2091-2100	-5.0 (2.9)	-1.6 (3.7)	13.4 (3.1)	31.5 (3.5)	52.7 (2.3)	65.2 (3.5)	69.0 (4.4)	63.4 (3.4)	48.4 (2.1)	28.9 (2.4)	7.1 (2.2)	-0.1 (3.0)

Projected monthly precipitation for Anaktuvuk Pass



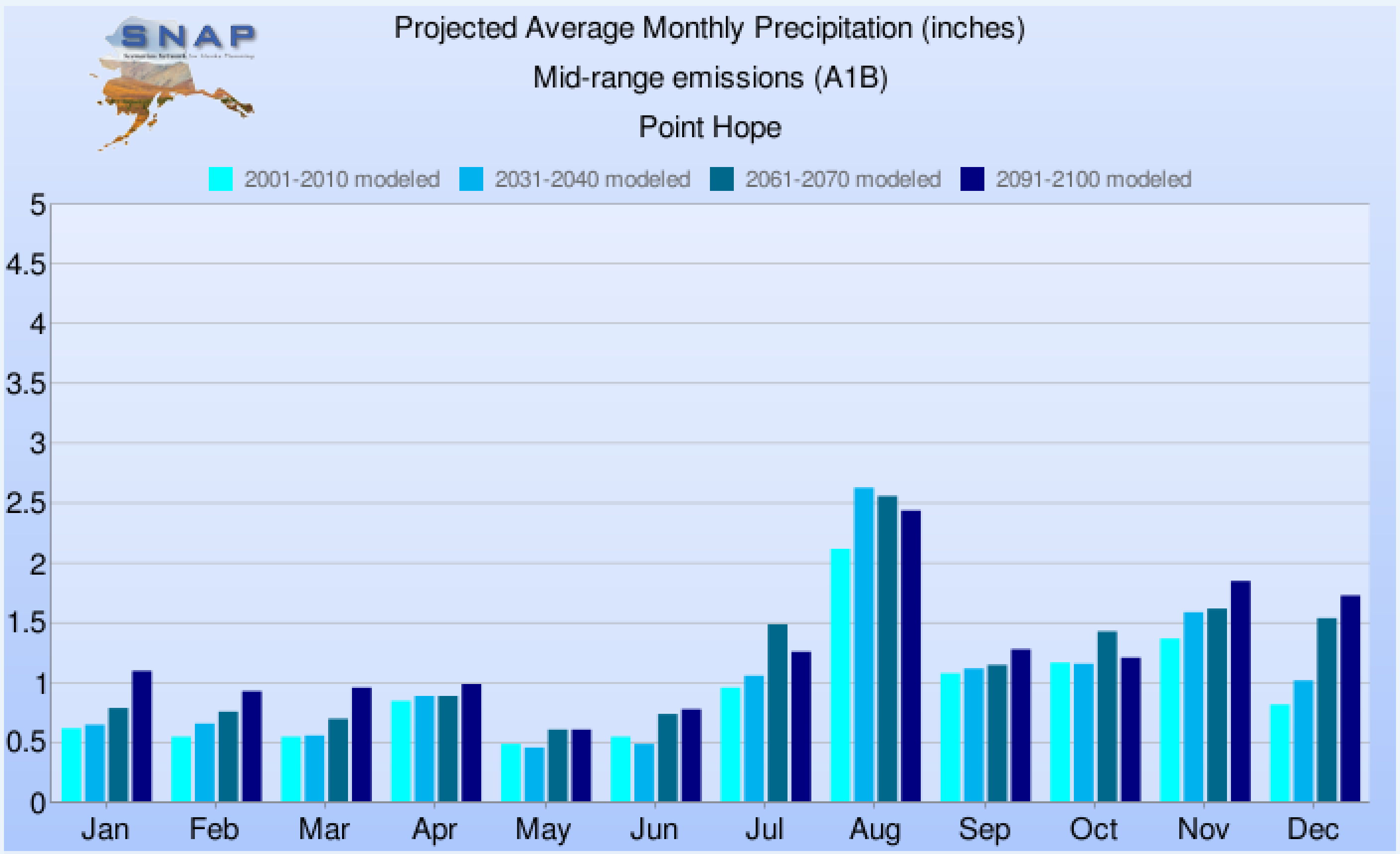
Temperature | **Precipitation**

www.snap.uaf.edu

Future Greenhouse Gas Emissions:

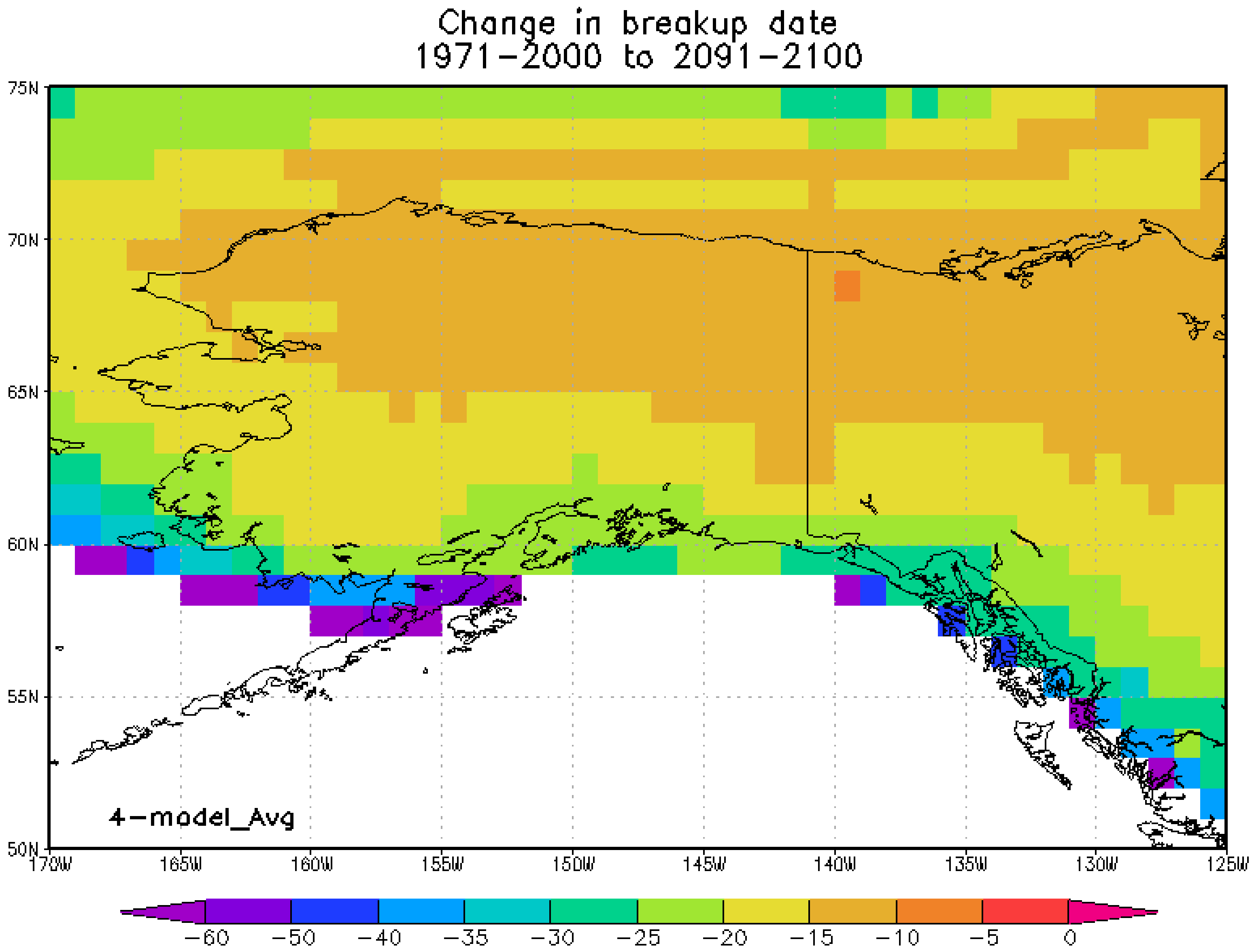
Low **Medium** High

Details
Print
Download

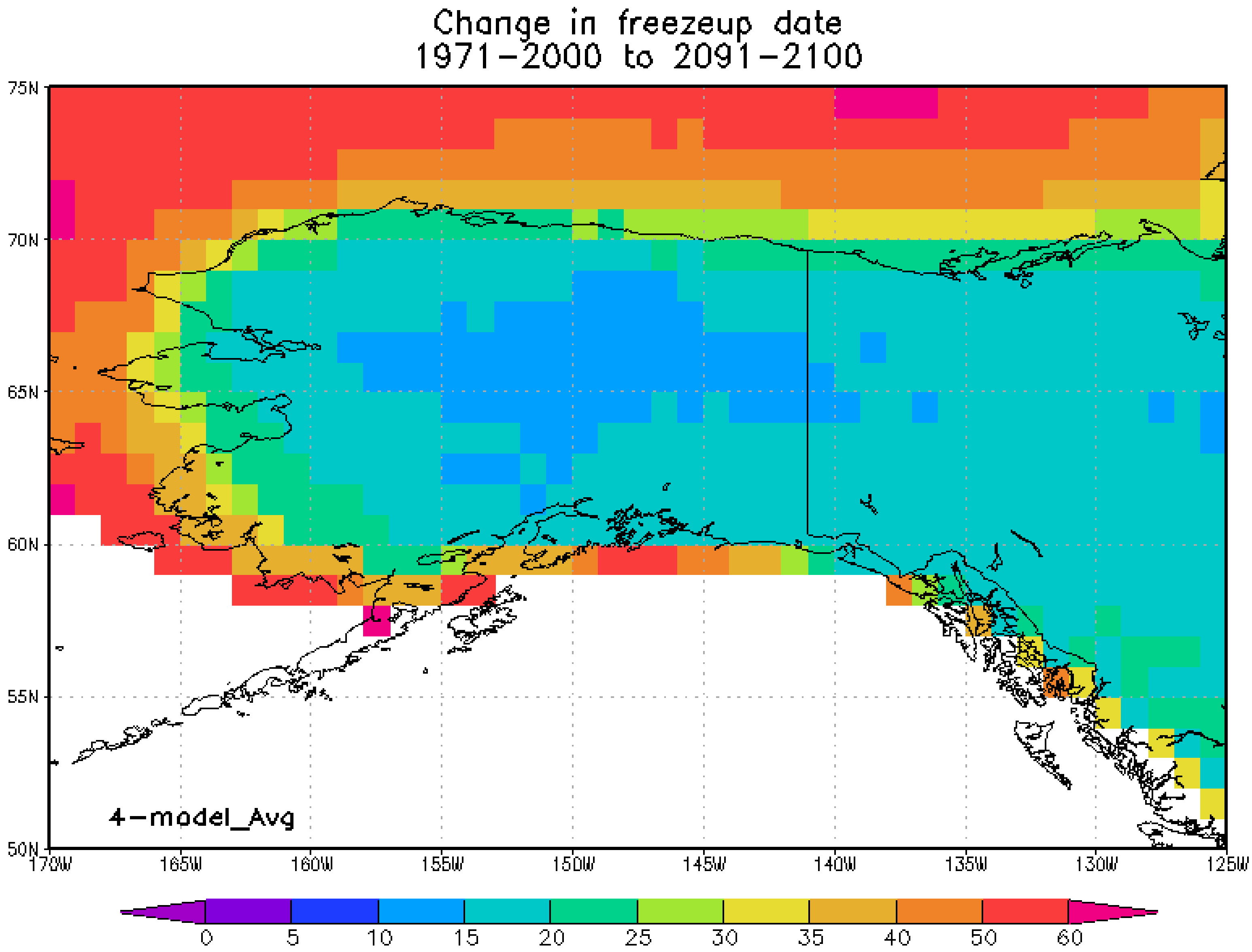


This graph shows average values from projections from five global climate models used by the Intergovernmental Panel on Climate Change. Due to variability among models and among years in a natural climate system, such graphs are useful for examining trends over time, rather than for precisely predicting monthly or yearly values. For more information on the SNAP program, including derivation, reliability, and variability among these projections, please visit www.snap.uaf.edu.

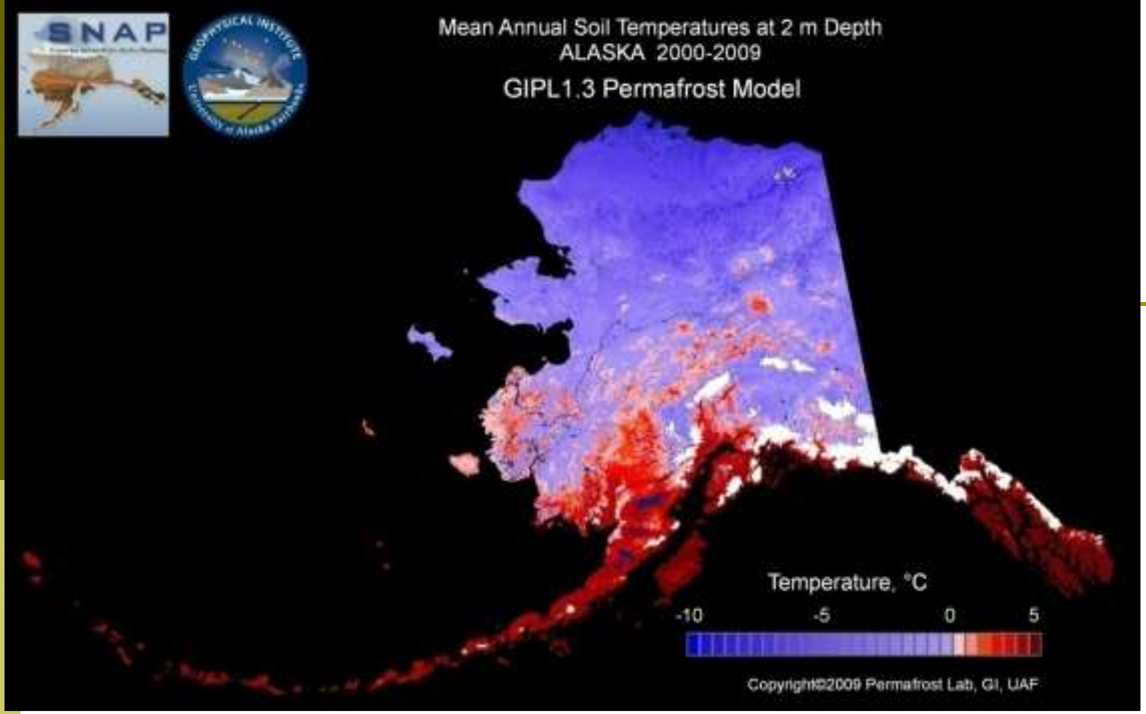
IPCC model projections of change in thaw date by 2091-2100



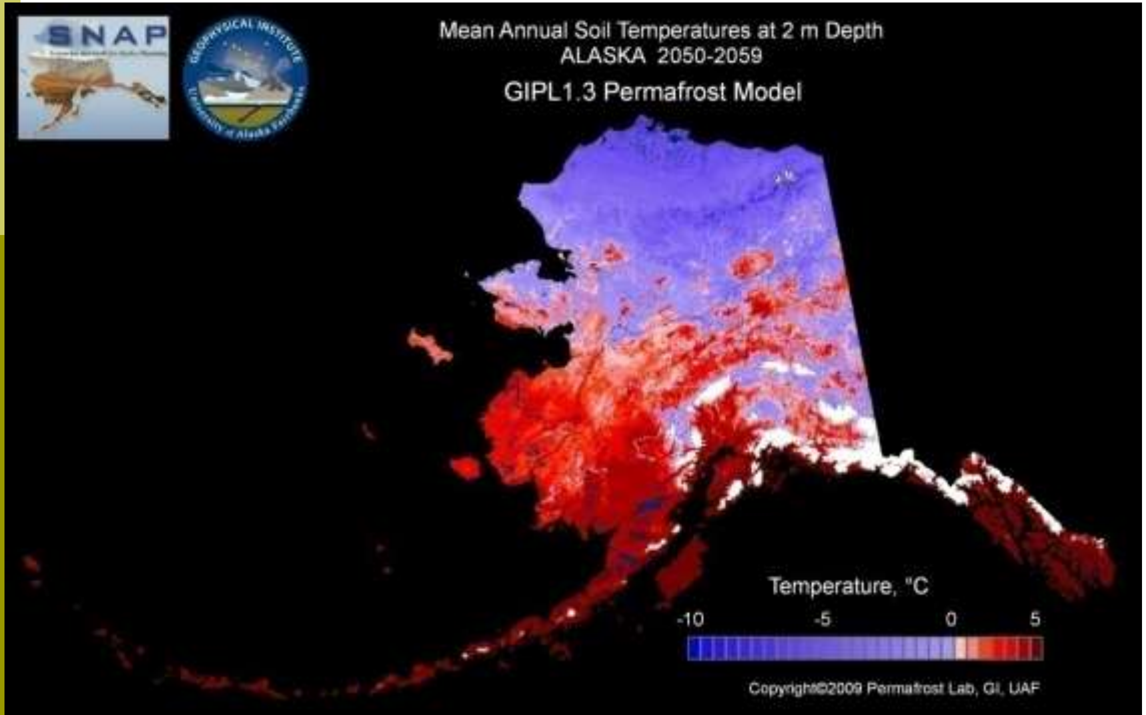
IPCC model projections of change in freeze-up by 2091-2100



Mean annual soil temp. (2 m depth)

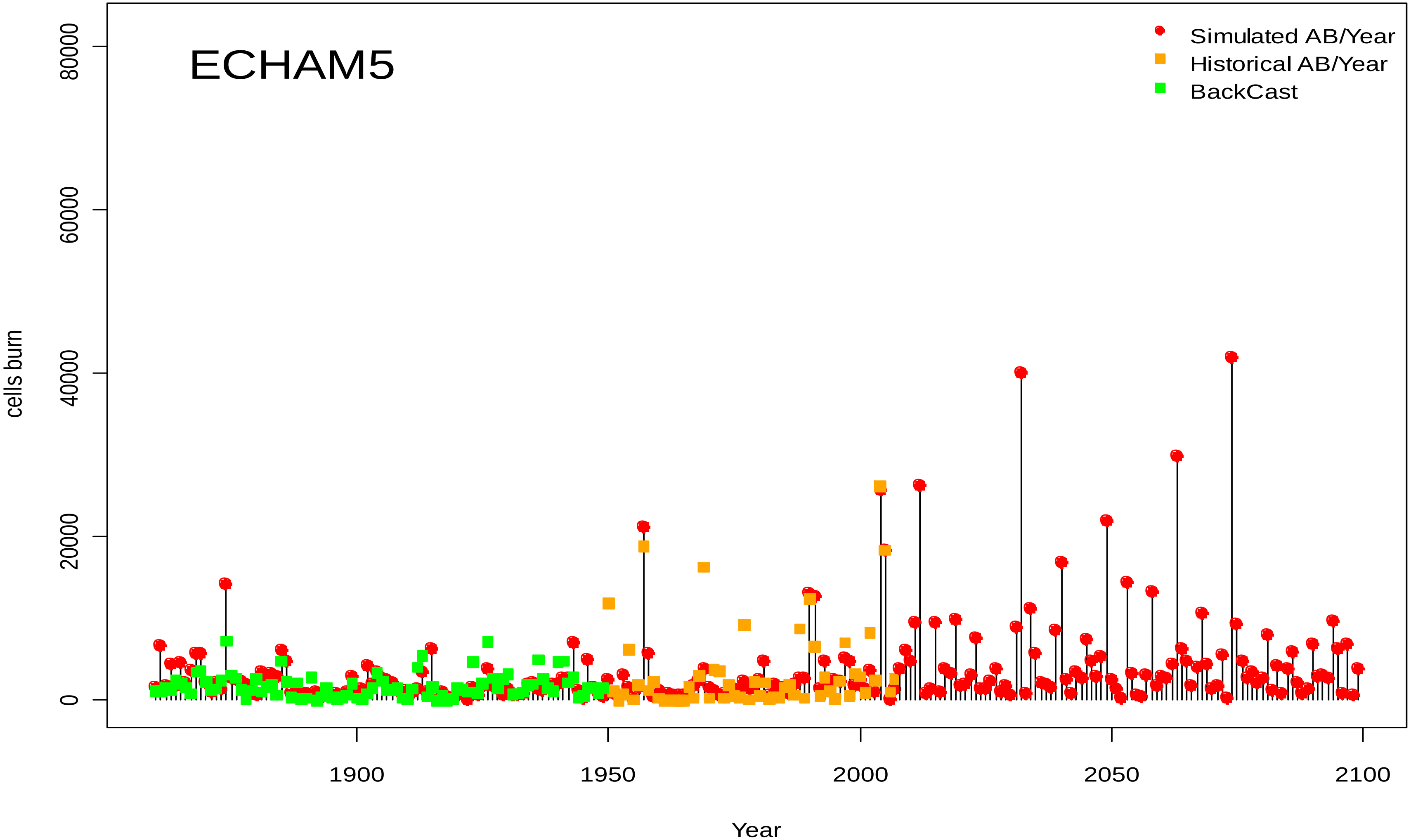


← 2000-2009



← 2050-2059

Simulated annual burn area in Alaska (ALFRESCO)



Which of the following temperature –related drivers seem most important in your region?

a) warm season length
b) extreme days
c) freshwater temperature
d) other

Which of the following precipitation –related drivers seem most important in your region?

a) rain
b) snow
c) water availability for plants
d) humidity

Which of the following other climate–related drivers seem most important in your region?

a) PDO
b) wind speed
c) storms
d) other

Critical Uncertainties

Example: Southwest Alaska Network (SWAN) group

Less	Water availability	More
Normal	Stream/lake temps	Warmer
Less	River basin hydrology	More
Measureable	Ocean Acidification	Catastrophic
Historical	Extreme precip/storms	Significant increase
Negative (colder)	PDO	Positive (warmer)

Climate Drivers

- Climate drivers are the **critical forces** in our scenarios planning process.
- Critical forces generally have unusually **high impact** and unusually **high uncertainty**.
- Climate drivers table specific for SE Alaska were compiled by John Walsh and Nancy Fresco of SNAP (see handouts).
- All scenarios are created by examining the intersection of two drivers, creating four sectors.
- **Selection of drivers** is crucial to the planning process.

Climate Effects

Climate effects are the outcomes of the critical forces or drivers, as expressed by significant changes in particular parks.

Points to consider include:

- Time frame (20 years? 100 years?)
- Uncertainty (of both driver and effect)
- Severity of effect (and reversibility)
- Scope: what parks, who is impacted?
- Repercussions: what is the story?
- Feedback to policy